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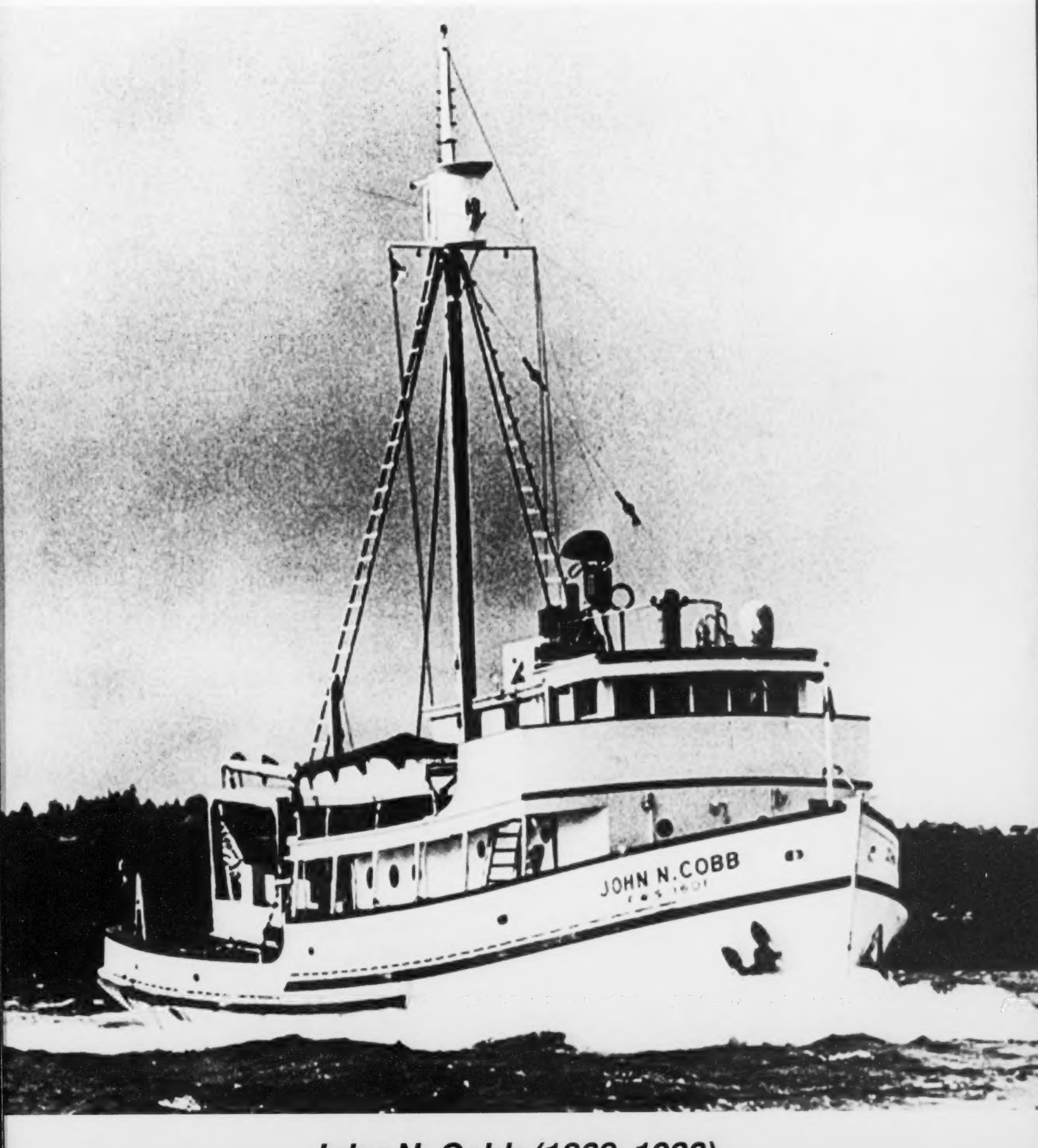

John N. Cobb (1868–1930)

Marine Fisheries REVIEW

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On the cover: The Bureau of Commercial Fisheries (pre-NOAA) ship John N. Cobb. Image number THEB0343 from the NOAA Ship Collection in the NOAA Photo Library.

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John Nathan Cobb (1868–1930): Founding Director of the College of Fisheries, University of Washington, Seattle

J. RICHARD DUNN

Introduction

John Nathan Cobb (1868–1930), author, naturalist, conservationist, and canneryman (Fig. 1), was one of the last of a breed of men who attained a high position in academia without the benefit of a college education.[1] In a career that began as a printer's aide for a newspaper, he worked as a stenographer and clerk, a newspaper reporter, a "Field Agent" for the U.S. Fish Commission (USFC) and its successor, the U.S. Bureau of Fisheries, as an editor for a commercial fishing trade magazine of the Pacific Northwest, and as a supervisor for companies in the commercial fishing industry. In 1919, Cobb was appointed the founding director of the College of Fisheries at the University of Washington (U.W.), the first such college established in the United States.

Thus, through self-education, hard work, and ambition, Cobb rose from unpretentious beginnings to become a dean in a major university. Cobb's career was testimony not only to the democratic ideals of the United States, but it also was evidence of his competence and an affirmation of the high level of esteem in which he was held by his peers. He excelled in knowledge of the commercial fisheries industry.

Cobb's tenure as director (later, dean) of the College of Fisheries from 1919 to 1930 must be considered success-

[1] Cobb was listed as "author, naturalist" in *Who was Who in America*, 1897–1942 (Anonymous, 1943). Joanne C. Webb described Cobb as a "conservationist and canneryman" in an analysis of Cobb's career. Webb, J. C. 1986. John N. Cobb: Conservationist and canneryman. Unpubl. B.A. Thesis, Scripps College, Calif., 95 p. Hayes (1959) discussed the development of the "conservation" movement in the early 20th century.

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ABSTRACT—John Nathan Cobb (1868–1930) became the founding Director of the College of Fisheries, University of Washington, Seattle, in 1919 without the benefit of a college education. An inquisitive and ambitious man, he began his career in the newspaper business and was introduced to commercial fisheries when he joined the U.S. Fish Commission (USFC) in 1895 as a clerk, and he was soon promoted to a "Field Agent" in the Division of Statistics, Washington, D.C. During the next 17 years, Cobb surveyed commercial fisheries from Maine to Florida, Hawaii, the Pacific Northwest, and Alaska for the USFC and its successor, the U.S. Bureau of Fisheries. In 1913, he became editor of the prominent west coast trade magazine, Pacific Fisherman, of Seattle, Wash., where he became known as a leading expert on the fisheries of the Pacific Northwest. He soon joined the campaign, led by his employer, to establish the nation's first fisheries school at the University of Washington. After a brief interlude (1917–1918) with the Alaska Packers Association in San Francisco, Calif., he was chosen as the School's founding director in 1919. Reflecting his experience and mindset, as well as the University's apparent initial desire, Cobb established the College of Fisheries primarily as a training ground for those interested in applied aspects of the commercial fishing industry. Cobb attracted sufficient students, was a vigorous spokesman for the College, and had ambitions plans for expansion of the school's faculty and facilities. He became aware that the College was not held in high esteem by his faculty colleagues or by the University administration because of the school's failure to emphasize scholastic achievement, and he attempted to correct this deficiency. Cobb became ill with heart problems in 1929 and died on 13 January 1930. The University soon thereafter dissolved the College and dismissed all but one of its faculty. A Department of Fisheries, in the College of Science, was then established in 1930 and was led by William Francis Thompson (1888–1965), who emphasized basic science and fishery biology. The latter format continues to the present in the Department's successor, The School of Aquatic and Fishery Sciences.

Figure 1.—John Nathan Cobb [*ca.* 1918]. University of Washington Archives, U.W. 18608.

ful, based upon the number of students enrolled in the College as well as in the records of attainment of its graduates. Cobb's approach to the educational focus of the College reflected his experience and mind-set, focusing on the practical applied aspects of the commercial fishing industry. Initially, this approach was also that favored by the University administration.

By the time of his death in 1930, however, it became apparent that his educational philosophy was out of date and was not accepted by the new University administration because of the College's failure to emphasize scholarly achievement. This was demonstrated by the rapid termination of the College by the U.W. administration upon Cobb's passing in 1930 (Stickney, 1989).

Cobb became a well-known "professional" naturalist of his day and his reputation was based on his keen knowledge of the commercial fisheries industry which was reflected in his many publications. He was a skilled compiler of fisheries catch statistics, and he produced well-received books on the fisheries of both Pacific salmon, *Oncorhynchus* spp., and Pacific cod, *Gadus macrocephalus*. Cobb's position as Dean of the College of Fisheries at the University of Washington emphasized his role as a leading national expert on fisheries.

This account describes Cobb's career and his ascendancy in 1919 to the directorship of the newly founded College of Fisheries at the U.W. I first provide a sketch of his professional life as naturalist, author, and "canneryman," and then outline the "campaign" to establish a school of fisheries at the U.W. as well as Cobb's appointment to it as the founding director. Cobb's educational goals are presented, as are his nascent ventures into research on the passage of fish over high dams. I examine the success of the College during its first decade of existence and describe its demise upon Cobb's death. Briefly noted is the school's reemergence in late 1930 as a school dedicated to the newly developing profession of fisheries science.

This work is based primarily on the papers of John N. Cobb housed in the Manuscripts, Special Collections, and University Archives of the U.W. Libraries, relevant material in the archives of the School of Aquatic and Fishery Sciences, U.W., and Cobb's published and unpublished works.[2] A history of the School of Fisheries, published by Stickney (1989), provided a basic roadmap for a detailed inquiry of Cobb's career at the University of Washington. The College of Fisheries has undergone several name changes over the years. It was a College from 1919 to 1930, a Department of Fisheries from 1930 to 1934, a School of Fisheries from 1934 to 1958, a College of Fisheries, again, from 1958 to 1981, a School of Fisheries from 1981 to 2000, and in 2000 was renamed the School of Aquatic and Fishery Sciences. A brief history of the School of Fisheries, based on Stickney's (1989) book, is posted on the School's web site.[3]

John N. Cobb, Author and Naturalist

John Nathan Cobb was born in Oxford, N.J., on 20 February 1868, the son of Samuel Spencer Cobb (1842–1921), a railroad engineer, and Louise Catherine Richard (1845?–1918), a native of Belfort, France. He was one of at least twelve children in the family (Fig. 2).[4] His vitae indicates that he attended "public schools" and discontinued his education at an early age to go to work.

The family apparently moved in the 1880's to Pennsylvania, and records indicate that in 1884, at the age of 16 years, he was working for a Pennsylvania newspaper, the *Carbondale Reader* (Fig. 3). He rose to become an editor of that periodical. For the next 15 years or so, Cobb worked, apparently as a stenographer and typist, in a variety of positions for a railroad company, a law firm, a supply and machinery enterprise, and a brick manufacturing company.

Cobb successfully passed a Civil Service examination in 1895 for the U.S. Government that qualified him for a position as stenographer and typist at a salary of $720 per year. He accepted a position in Washington, D.C., on 1 July 1895 with the U.S. Fish Commission[5], where he was appointed clerk in the Division of Statistics.[6] He was promoted to "Field Agent" on 11 February 1896 at a salary of $1,000 per annum, and was responsible for collecting commercial fishery statistics. Thus Cobb began a career in fisheries that was to last until his death 35 years later and one that led to his recognition as an "expert" in fisheries statistics.[7]

Cobb's position with the "Fish Commission" demanded considerable travel, as he was required to proceed throughout the eastern seaboard to collect statistics on the commercial catch of fish and shellfish. For example, in 1896–97 Cobb visited Jacksonville, Fla.; Havre de Grace, Md.; Key West, Fla.; Wilkes-Barre, Pa.; Key West again; and Cape Vincent, N.Y. After most of these trips he returned to the USFC headquarters in Washington, D.C. This pattern of frequent travel continued

[2] David Henken wrote a Senior Paper for the U.W. History of Science course that dealt primarily with Cobb's venture into fish passage research in the 1920's. Henken, D. 1999. John Nathan Cobb: Cooperation between hydro and fisheries in the 1920's. Unpubl. manuscr., Univ. Wash., 74 p.

[3] www.fisheries.washington.edu/history/html.

[4] Honor Conklin, Albany, N.Y., personal commun., 24–25 Nov. 2003.

[5] The U.S. Commission of Fish and Fisheries was founded as an independent agency in 1871 and is commonly referred to as the U.S. Fish Commission (USFC). Effective 1 July 1903, the U.S. Congress changed the name of the U.S. Fish Commission to the U.S. Bureau of Fisheries and placed it administratively in the U.S. Department of Commerce and Labor.

[6] University of Washington Libraries, Manuscripts, Special Collections, and University Archives (hereafter University of Washington Archives). John Nathan Cobb papers, Accession No. 1595-6, Box 1, Folder 3. Cobb at an early age was quite interested in forging a career. He frequently solicited letters of recommendation from his employers during 1884–95, many of which are present in the Cobb papers. Cobb also left a large collection of photographs of the College, the university, fisheries scenes, and other topics, present in the University of Washington Archives, Cobb Collection, No. 418.

[7] University of Washington Archives, Accession No. 1595-6, Box 2, Folder 10, U.S. Bureau of Fisheries, 1895–1903. Cobb married Harriet Collin Bidwell (1869–1941), a cousin, in 1898 and the couple had one daughter, Genevieve Catherine (1900–1977). Genevieve graduated in zoology from the University of Washington and, after receiving a degree in librarianship at the U.W., became a librarian at Princeton University until her retirement. Honor Conklin, personal commun., 24–25 Nov. 2003; Anonymous, 1943.

Figure 2.—Young John N. Cobb [n.d.]. Courtesy of Honor Conklin, Albany, N.Y.

Figure 3.—Young John N. Cobb [n.d.]. Courtesy of Honor Conklin, Albany, N.Y.

through 1900.[8] Cobb's first publication for the Fish Commission, on the fisheries of Lake Ontario, was issued in 1898 (Cobb, 1898). He produced about 18 scientific publications and books during his tenure with the Fish Commission from 1895–1911 (Table 1).

In May 1901, Cobb was assigned to investigate the fisheries of the Hawaiian Islands. This project, part of a larger study of the aquatic resources of the Islands, was led by Barton Warren Evermann (1853–1932), a noted ichthyologist for the Fish Commission. The trip lasted nearly 3 months as Cobb canvassed the commercial and "native" fisheries of the Islands, after which Cobb was directed to proceed to Stanford University, Calif., to help finish the report on the investigations.[9] A major publication resulted from this program (Jordan and Evermann, 1902) and Cobb authored a chapter in it (Cobb, 1902). This expedition put him in contact with the leading ichthyologist of the era, David Starr Jordan (1851–1930)[10], the President of Stanford University, a connection that was to serve him well later.[11]

Cobb was directed by the Bureau of Fisheries to return to Hawaii in early 1904 where he compiled catch statistics collected in 1903 so as to compare them to those collected in 1901. The fisheries statistics he collected in the Islands resulted in a paper, *The Commercial Fisheries of Hawaii,* which was published by the Bureau (Cobb, 1905).

In 1904 Cobb began to lobby the Bureau of Fisheries for a position in Alaska. He asked Dr. Jordan to write a letter in support of his request to become

[8] University of Washington Archives, Accession No. 1595-6, Box 2, Folder 10, U.S. Bureau of Fisheries, 1895–1903.

[9] University of Washington Archives, Accession No. 1595-6, Box 2, Folder 10, U.S. Bureau of Fisheries, 1895–1903. Evermann later became Director of the Calif. Academy of Sciences, San Francisco. Additional information about Evermann may be found in Hanna and Peers (1944) and Jennings (1997).

[10] For more on Jordan, see Snyder (1905) and Hubbs (1964). Jordan's autobiography contains a wealth of information about the fisheries of the late 19th and early 20th centuries (Jordan, 1922). For more information on Stanford University and that school's role in fisheries education, see Brittan (1997).

[11] Jordan to Cobb, dated Stanford University, 26 July 1901. University of Washington Archives, Accession No. 1595-6, Box 2, Folder 10.

Table 1.—Fisheries publications of John N. Cobb during his tenure with the U.S. Bureau of Fisheries, 1895–1912. University of Washington Archives, Accession No. 1595-6, Box 2, Folder 10.

Author(s)	Year Publ.	Title of paper	Journal
Cobb, J. N.	1898	The fisheries of Lake Ontario in 1897	Rep. New York Comm., Fish. Game, Forests, p. 205–221
Cobb, J. N.	1898	Possibilities for an increased development of Florida's fishery resources	Bull. U.S. Fish. Comm. 17:349–351
Cobb, J. N.	1899	The commercial fisheries of Lake Erie, Lake Ontario And Niagara and St. Lawrence Rivers	Fifth Ann. Rep., New York Comm. Fish., Game and Forests, 1899:189–239
Cobb, J. N.	1900a	The lobster fishery of Maine	Bull. U.S. Fish Comm. 19:241–265
Cobb, J. N.	1900b	The sturgeon fishery of the Delaware River and Bay	Rep. U.S. Comm. Fish for 1899:369–380
Cobb, J. N.	1902	Commercial fisheries of the Hawaiian Islands	Rep. U.S. Comm. Fish Fish. 1901, 27:383–499
Cobb, J. N.	1903a	The sponge fisheries of Florida in 1900	U.S. Bur. Fish. Doc. 585:161–175
Cobb, J. N.	1905a	The commercial fisheries of the interior lakes and rivers of of New York and Vermont	Rep. U.S. Fish Comm. for 1903:225–246
Cobb, J. N.	1905b	The commercial fisheries of the Hawaiian Islands in 1904	Rep. Bur. Fish. 1904:433–511
Cobb, J. N.	1906a	The commercial fisheries of Alaska	U.S. Bur. Fish. Doc. 603, 46 p.
Cobb, J. N.	1906b	Investigations relative to the shad fisheries of North Carolina	North Carolina Geol. Surv., Econ. Pap. No. 12, 42 p.
Cobb, J. N.	1907	Report on the fisheries of Alaska in 1906	Rep. Comm Fish. 1906 and Spec. Pap. Bur. Fish. Doc. 618, 24 p.
Marsh, M. C., and J. N. Cobb.	1908	The fisheries of Alaska in 1907	Rep. Comm. Fish. 1907 and Spec. Pap. Bur. Fish. Doc. 632, 64 p.
Marsh, M. C., and J. N. Cobb.	1909	The fisheries of Alaska in 1908	Rep. Comm. Fish. 1908 and Spec. Pap. Bur. Fish. Doc. 645, 78 p.
Marsh, M. C., and J. N. Cobb.	1910	The fisheries of Alaska in 1909	Rep. Comm. Fish. 1909 and Spec. Pap. Bur. Fish. Doc. 730, 58 p.
Cobb, J. N.	1910	The king salmon of Alaska	Trans. Am. Fish. Soc. 39:124–129.
Marsh, M. C., and J. N. Cobb.	1911	The fisheries of Alaska in 1910	Rep. Comm. Fish. 1910 and Spec. Pap. Bur. Fish. Doc. 746, 72 p.
Cobb, J. N.	1911	The salmon fisheries of the Pacific Coast	U.S. Bur. Fish., Doc. 751, 180 p.

a Field Agent in that territory.[12] Cobb obtained the desired position in February 1905, and his appointment as "Assistant Agent" paid $200 per month.[13] Still based in Washington, D.C., Cobb traveled to Alaska each summer to observe the commercial salmon fisheries and to collect catch statistics. He was apparently a conscientious worker and was known for his aggressive enforcement of fishery regulations.[14] Additionally, Cobb was writing books and reports about fisheries. These included annual reports from 1905 to 1910 on the fisheries of Alaska (e.g. Cobb, 1907; Marsh and Cobb, 1911) and a book, "*The Salmon Fisheries of the Pacific Coast*" (Cobb, 1911).[15]

By early 1911, Cobb was eager for a transfer from Washington, D.C., to the west coast. In March of that year he wrote George Mead Bowers (1863–1925), Commissioner of the U.S. Bureau of Fisheries, asking to be transferred to Seattle.[16] His request was denied, so Cobb turned to the private sector for employment. On 5 March 1912, Cobb wrote again to Commissioner Bowers, this time tendering his resignation:

"Feeling that there is little, if any, opportunity in the Bureau for the advancement of an economic man, and having received an excellent offer from the Union Fish Company of San Francisco, I have decided to resign my office in the Bureau in order to accept the new position, and herewith enclose my resignation."[17]

Cobb thus left the employ of the U.S. Bureau of Fisheries to pursue greener paths. He never worked for the Bureau again, but he was always interested in returning if an attractive position became available.

Ventures into the Commercial Realm: Cobb as "Canneryman" and Editor

Cobb joined the Union Fish Company in San Francisco in the spring of 1912 in

[12] See Cobb to Jordan [n.d., but 1904]. University of Washington Archives, Accession No. 1595-6, Box 2, Folder 11. This was the era of political patronage and the President often made (recommended) appointments of people to various government positions. For example, Cobb again enlisted the help of Jordan in 1909 to get re-appointed to his position as a Field Agent in Alaska. Fred Warner Carpenter (1873–1957), Secretary to President William Howard Taft (1857–1930), to Charles Nagel (1849–1940), Secretary of Commerce and Labor, dated Washington, D.C., 15 May 1909. University of Washington Archives, Accession No. 1595-6, Box 1, Folder 3. See also Nagel to Carpenter, dated Washington, D.C., 18 May 1909. This letter of reappointment of Cobb cites the recommendation of Jordan. University of Washington Archives, Accession No. 1595-6, Box 2, Folder 12.

[13] Victor Howard Metcalf (1853–1936), Secretary of Commerce and Labor, to Cobb, dated Washington, D.C., 16 Feb. 1905. University of Washington Archives, Accession No. 1595-6, Box 2, Folder 11. Henken (footnote 2) reviewed Cobb's years with the Bureau of Fisheries.

[14] Boyce, J. U.S. Attorney for the Division of Alaska, to Cobb, dated Juneau, 30 Dec. 1906. University of Washington Archives, Accession No. 1595-6, Box 1, Folder 3. As an example, Cobb reported to Bureau headquarters that Alaska fish processors were using only the belly of pink (*O. gorbuscha*) and other species of salmon and wasting the remainder of the fish, in violation of the law. University of Washington Archives, Accession No. 1595-6, Box 2, Folder 12. See also Henken, footnote 2.

[15] In January 1909, Cobb was temporarily detailed to the U.S. Census Bureau to survey various fisheries. In February 1910, he was again temporarily detailed to survey the fisheries of Northern Calif., Washington, and Oregon. University of Washington Archives, Accession No. 1595-6, Box 2, Folder 12. He was sent in May 1911 to Seattle to canvas the halibut fishery. University of Washington Archives, Accession No. 1595-6, Box 2, Folder 13.

[16] Cobb to George M. Bowers, dated Washington, D.C., 28 Mar. 1911. University of Washington Archives, Accession No. 1595-6, Box 2, Folder 13.

[17] Cobb to Bowers, dated San Francisco, 5 Mar. 1912. University of Washington Archives, Accession No. 1595-6, Box 2, Folder 13. Cobb did not cut his links to the Bureau, as he offered in this letter to aid the Bureau in the future in any way he could. Cobb wrote similar letters to Hugh McCormick Smith (1865–1941), who was to succeed Bowers as Commissioner later in the year; to Jordan and Evermann, as well as to President William Howard Taft, among others. University of Washington Archives, Accession No. 1595-6, Box 2, Folder 13.

a management position at a considerable increase in salary. The company fished for Pacific cod in Alaska, and Cobb traveled north on the company boats, the *Union Jack* in 1912 and the *Sequoia* in 1913, operating out of Sand Point and Unga, Alaska.[18] Cobb's experience with the Union Fish Company was not satisfactory, as he apparently was not granted the freedom to manage as he had hoped, and he left the company in November 1913 on good terms.[19]

Cobb sought to improve his position, as he continually did, and in November 1913 the commercial fishing trade magazine *Pacific Fisherman* (Fig. 4) based in Seattle, hired him, though at a significantly lower salary than that paid by the Union Fish Company. In his letter of acceptance, Cobb agreed to move to Seattle about 15 November 1913 and to accept a salary of $40 a week "for the present." His salary at the Union Fish Company was $200 a month.[20] This monthly publication was the preeminent voice for the fishing industry of the west coast. He was hired as the editor of the publication and his particular experience in fisheries for the Bureau of Fisheries and the Union Fish Company brought rare skills to the magazine. The owner of the periodical, Legh Miller Freeman (1875–1955), became a power in the commercial fisheries industry and in fisheries conservation efforts. The *Pacific Fisherman* was a large format magazine devoted to all aspects of the fishing industry on the west coast. It paid particular attention to fishing developments in Alaska, and Cobb's experience in that territory was likely valuable to the magazine.[21]

Cobb remained with the magazine for 4 years. During this period he established himself as an informed observer of the commercial fishing and fisheries scenes. As editor, Cobb most likely had wide latitude over what was published in the journal. He wrote articles that appeared in the journal under his byline, such as "Utilizing waste products in the salmon industry" (Cobb, 1913), and "New methods in Pacific coast fisheries" (Cobb, 1915a). Cobb reviewed "The future of Alaska's fisheries" in the journal's Alaska Fisheries Number in 1914 (Cobb, 1914a) and wrote about Pacific coast fishing methods in the journal's 1916 annual yearbook number (Cobb, 1916c).

Cobb also wrote for the scientific world, publishing in professional journals. An example of the latter includes "Pacific halibut fishery declining" (Cobb, 1915c), published in the *Transactions of the American Fisheries Society*. During his years with the periodical he published one book *Pacific Cod Fisheries* (Cobb, 1916b), a revised edition of which was issued in 1927, and in 1917 he published a revised version of his book, *Pacific Salmon Fisheries* (Cobb, 1917).[22]

Cobb helped found the Pacific Fisheries Society in Seattle in 1914. Patterned after the American Fisheries Society, the new organization was directed toward the interests of fisheries workers, mainly scientific but also for members of the commercial industry, of the U.S. west coast (Anonymous, 1914a, d). The Society produced an annual publication, at least in 1914 and 1915, titled *Transactions of the Pacific Fisheries Society* (with Cobb as editor and publisher), in which Cobb published articles (e.g. Cobb 1915b, 1916a). Cobb was Secretary of the organization in 1914–15 and President in 1921 and 1923. Active membership in this new organization enabled Cobb to meet and to socialize with the leading men in both the scientific and commercial aspects of the Pacific coast fisheries (Fig. 5).[23]

Although successful as an editor, Cobb entertained visions of returning to work for the Bureau of Fisheries. In May 1914, the U.S. Bureau of Fisheries Commissioner Hugh McCormick Smith telegraphed Cobb asking whether or not he could take a temporary job with the Bureau to investigate salmon fishing conditions in Siberia. Cobb was apparently unable to accept the offer, likely due to his current job. However, he wrote to Smith indicating his interest in heading the Seattle office of the agency. Smith offered Cobb the requested position in November 1914 and asked when he might begin work. Cobb responded, the "quicker the better."[24] Cobb was advised by an official of the Bureau, however, that the Secretary of Commerce, William Cox Redfield (1858–1932), was "opposed to the appointment of any person connected with a trade journal or with any fishing company or organization."[25] Cobb then withdrew his name

[18] University of Washington Archives, Accession No. 1595-6, Box 8, Folder 5. Cobb kept personal diaries, apparently from 1897–1927, many of which are present in the Cobb papers. His diary for his years with the Union Fish Company contains details of his work with the company as well as personal notes. University of Washington Archives, Accession No. 1595-6, Box 8, Folder 5.

[19] Webb (footnote 1) briefly described Cobb's aborted career with Union Fish Company.

[20] University of Washington Archives, Accession No. 1595-6, Box 1, Folder 30.

[21] Freeman wrote an unpublished autobiography. Freeman, M. 1956. The memoirs of Miller Freeman, 1875–1955. Upubl. manuscr., 166 p. A daughter-in-law published a biography of Freeman (Wright, 1977). More information about fisheries issues of the era is provided by Dewitt Gilbert (1896–1981), a former editor of *Pacific Fisherman* (Gilbert, 1988).

[22] A partial list of Cobb's publications, as well as many reprints of his articles, are present in the University of Washington Archives, Accession No. 1595-6, Box 1, Folder 1 and Box 15, Folder 1.

[23] The U.W. Library has the *Transactions* for only 1914 and 1915. I was unable to determine if later issues of the *Transactions* were issued. A "List of members, *Pacific Fisheries Society* for notification, 1923–1924," is present in the University of Washington Archives, U.W. Fisheries papers, Accession No. 74-6, Box 25, Folder 7.

[24] Telegram, Smith to Cobb, dated Washington, D.C., 1 May 1914. I did not locate Cobb's response to Smith's telegram. There are several letters in the Archives, however, concerning his attempt to secure employment with the Bureau in 1914. See Cobb to Smith, dated Seattle, 2 May 1914. Smith to Cobb dated Washington, D.C. 14 May 1914; Smith to Cobb, dated Washington, D. C., 2 Nov. 1914; Cobb to Smith, dated Seattle, 7 Nov. 1914; Smith to Cobb, dated Washington, D.C., 13 Nov. 1914; and Cobb to Smith, dated Seattle, 16 Nov. 1914. All in University of Washington Archives, Accession No. 1595-6, Box 2, Folder 14. See also Cobb to Smith, dated Seattle, 8 Nov. 1914, and Cobb to Smith, dated Seattle, 14 Nov. 1914. University of Washington Archives, Accession No. 1595-6, Box 1, Folder 30.

[25] Ward Taft Bower to Cobb, dated Washington D.C., 30 Dec. 1914, and marked "personal." University of Washington Archives, Accession No. 1595-6, Box 1, Folder 30. Bower (1881–1960), based in Washington, D.C., had been the Inspector of Alaska Salmon Fisheries for the Bureau. He was appointed to the position Cobb desired when the Bureau opened a Seattle office in 1914 (Anonymous, 1914c).

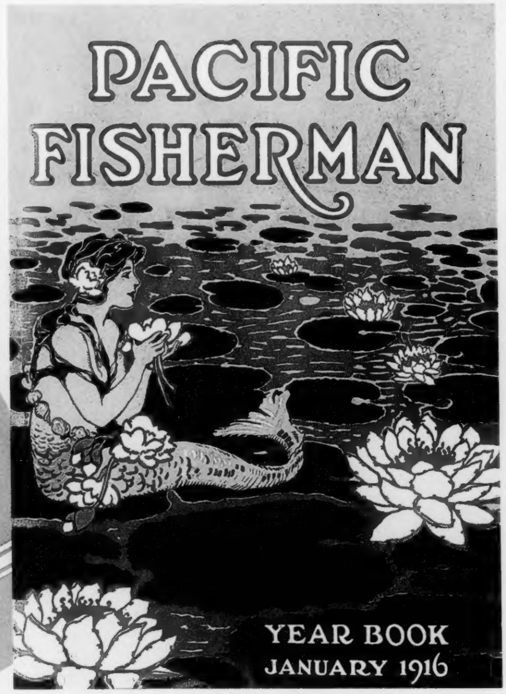


Figure 4.—(This page) Selected covers of *Pacific Fisherman* magazine from 1915 to 1917. University of Washington, Fishery-Oceanography Library. (Opposite) Page from *Pacific Fisherman*, August 1915.

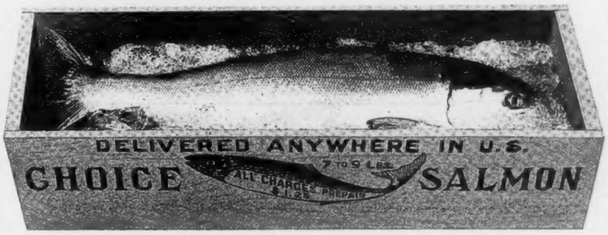
Pacific Fisherman

A Journal Devoted Exclusively to the Fishing Industry.
ISSUED ON THE FIFTH OF EACH MONTH

VOL. XIII. SEATTLE, WASHINGTON, AUGUST, 1915. NO. 8

Shipping Fish Direct to the Consumer

When C. H. Eggers, of Tacoma, first advertised that he would ship a salmon to anywhere in the United States, except over the Southern Express Company lines, for $1.25, which price included also all charges for handling the fish, he did not think that he would be the forerunner of a number of others who would not only follow but also enlarge upon his idea. He was soon followed by J. P. Todd, of Seattle, who is now the oldest dealer in this line on the Coast, Mr. Eggers having soon dropped out. For a while Mr. Todd had all of the business, but other concerns soon took it up, among them being the Pacific Salmon Company, Pacific Sales Company, Mail Order Fish Company, a'l of Seattle, and the Pacific Salmon Supply Company, of Tacoma. At the present time one can not only obtain a choice fresh salmon, but also may purchase salt, smoked and kippered salmon, salt codfish, and fresh halibut, smelt, crabs, and other sea food in season.



FRESH SALMON PACKED IN ICE FOR SHIPMENT BY EXPRESS.

While these shipments of salt fish may be made by either parcel post or express, it is probable that most of them go by the former. In shipping fresh fish, however, the conditions are different. The postoffice department will not accept packages in which ice is used for preserving fish. As a result of this regulation it is not possible to ship fresh fish beyond the first postal zone (up to 50 miles from the initial mailing point) except in winter, when the postmasters are also authorized, in their discretion, to accept shipments for the second zone (50 to 100 miles from the initial point). In making fresh fish shipments by parcel post frozen fish are generally used. As a result of the limitations on the parcel post the express companies have practically a monopoly of the fresh fish shipments, and also handle a considerable proportion of the smoked and salt shipments.

But few persons engaged in the fishing industry,

Pacific Salmon Co., Inc.
501 Northern Bank Bldg., Seattle, Wash.
Will Deliver One
CHOICE
SALMON
weighing from 7 lbs. to 9 lbs. dressed, to any express office in the U. S., all charges prepaid, for $1.25.
Carefully packed in ice, and re-iced daily by express company until destination is reached.
Guaranteed to arrive in prime condition. We also ship strictly Fresh Crabs, Smelt, Halibut, Kippered Salmon, Kippered Herring, and all other Sea Foods.
Correspondence Invited. Write Dept. F.

ONE OF THE ADVERTISEMENTS USED IN MAIL ORDER CAMPAIGN.

outside of those directly concerned, appreciate the immense help the express companies of this country have been in the development of the industry, and especially on this coast.

There is probably not a fresh fish dealer on this coast who did not, in his early business career when trying to enlarge the range of his shipments, dump onto the various express companies "Jerry" shipments of fresh fish. "Jerry" shipments are those shipped c. o. d. to the express agent in some town, the fish being billed to him also, with the understanding that he is to sell the fish to somebody and remit the proceeds to the shipper. In order to accommodate the shipper and increase the express company's business, and, incidentally, his own compensation, the agent would either place these fish with the local fish dealer or sell them retail to whoever cared for them.

In this way the young and struggling fish dealers of the coast would get into touch with the retail dealers in the various towns and ultimately build up a trade which would obviate the necessity for making "Jerry" shipments.

Probably three-fifths of the fresh fish sold in this country are handled by the express companies. In the early days the companies were much handicapped in carrying on the business by the lack of adequate and proper equipment. At that time

SALMON
7 TO 8 LB. ON ICE
DIRECT TO CONSUMER, $1.25
I will deliver a fine, fat Puget Sound Salmon to any express office in the U. S. (except Southern Express), express prepaid, for $1.25, weight 7 to 8 lbs. I guarantee it to be a genuine Puget Sound Salmon and I guarantee it to arrive in first-class condition.
The salmon season closes in March. Order now for yourself and send one of these delicious fresh fish to your friends back East. Send money order or bank draft. References, any bank in Seattle.
J. P. TODD, Colman Dock, Seattle, Wash.

A SMALL ADVERTISEMENT WHICH SOLD THOUSANDS OF SALMON.

refrigerating science was in its infancy, and all shipments had to be placed in boxes with cracked ice. As re-icing stations were infrequent, this necessarily restricted the shipments to comparatively short distances.

Today the companies are equipped with up-to-date refrigerator cars, in which fresh and frozen fish may be carried to any place on the continent to which the rail lines of this country extend, while in conjunction with the steamers in which refrigerator space is provided, shipments may be made to all the principal countries of the world.

Delicious Salmon
from
Puget Sound
Order by mail. We save you half the cost.
Send us $3.00 by P. O. Order or Express Money Order, and we will send you by freight or express as you prefer, f. o. b. Tacoma—
20-lb. Kit, Choice Salt Salmon, and
15 lbs. Selected Smoked Salmon.
Try them, then tell your friends.
PACIFIC SALMON SUPPLY
1011 A St., Tacoma, Wash.

TYPICAL SALMON MAIL ORDER COPY.

The installation of the parcel post by the U. S. government for a time caused a considerable falling off in the general business of the express companies. They immediately began to cast about for business to replace that lost, and the possibility of increasing their fish-carrying trade was one of the first taken up. The companies were quick to recognize the importance to them of the scheme of shipping fresh fish in small lots to individual consumers throughout the country, and extended every aid possible to these shippers.

In shipping individual fish the latter is packed in a box containing 20 pounds of cracked ice. These boxes are collected by the express company and are generally sent out in the company's own regular cars attached to the trains leaving in the evening. About every fifteen to twenty hours the box is opened and from five to seven pounds, depending upon the weather, of fresh cracked ice added to the box to make up the loss through melting.

When the industry began the companies notified their agents throughout the country, and immediately each one became a worker for the shipper. Naturally no effort was made to push one man's goods any more than another's, the aim of the companies being to help all.

The extent of the demand through the express agents varied greatly. Some agents evidently devoted more time to the work than others, this being especially noticeable in the small towns, where the agent has much more spare time on his hands than his brother in the larger towns. The Wells-Fargo agent at Kerrville, a small town near San Antonio, Texas, probably holds the record with a total of thirty-five orders for salmon in one day.

At first it was feared that this phase of the

SALES BOOTH USED BY PACIFIC SALMON CO. DURING "SHRINE WEEK" IN SEATTLE.

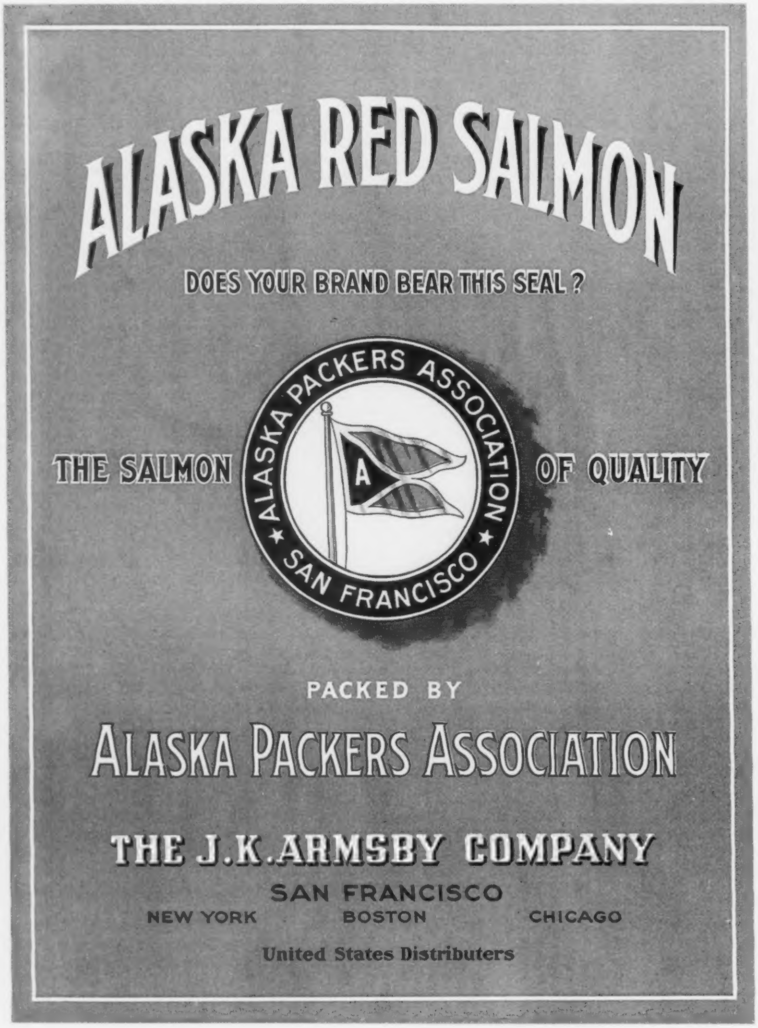
from consideration to avoid embarrassment for Commissioner Smith.[26]

[26] Cobb to Smith, dated Seattle, 6 Jan. 1915. University of Washington Archives, Accession No. 1595-6, Box 1, Folder 30. In 1915, the position of Deputy Commissioner of the Bureau became available. Cobb sent a telegram to Jordan asking the latter to write a letter of support for the position to President Woodrow Wilson (1856–1924) and Secretary of Commerce Redfield. Cobb to Jordan, dated Seattle, 13 Mar. 1915. University of Washington Archives, Accession No. 1595-6, Box 5, Folder 2. I did not locate any other correspondence concerning this request to Jordan.

Cobb, in early 1916, was then offered a position as General Superintendent with the Alaska Packers Association (APA) of San Francisco, Calif., at a salary nearly twice what he was receiving from the *Pacific Fisherman*. The Association was the largest and most influential commercial fishing enterprise in Alaska (Cooley, 1963). At that time APA operated the most fishing boats, employed the most workers, and canned the most salmon of any Alaska cannery. Cobb considered the potential of the position but, at the same time, longed for a return to the Bureau of Fisheries. A position with the latter agency was not forthcoming and, by the time Cobb responded affirmatively to the company, the position at APA had been filled. The position again became available in early 1917 and this time Cobb accepted the offer. Cobb signed a 5-year contract with APA to begin work on 29 January 1917. The terms of the contract allowed Cobb to resign his position within five years if the management of APA, to whom he was reporting, changed during his employment with the firm.[27] Cobb resigned from the *Pacific Fisherman* on 26 January 1917 to accept the position with APA.[28] His move to APA seemed part of his continuous desire to improve his status, economic and otherwise.

During the salmon fishing season in Alaska in the summers of 1917 and 1918, Cobb traveled north to visit the various APA concerns. His work involved inspecting the working and sanitary conditions in the canneries. Because of his previous work in Alaska with the Bureau of Fisheries, Cobb was familiar with most of the APA packing operations there.[29]

Cobb was apparently satisfied with his work with APA, but he again sought another position of advancement. Cobb's experience in the fisheries of Alaska, his former position at the *Pacific Fisherman,* and his involvement with the Pacific Fisheries Society placed him at



An advertisement for the Alaska Packers Association in the *Pacific Fisherman*, ca. 1915.

[27] There is much correspondence in the Archives between Cobb and Jefferson Moser about Cobb's possible employment with APA. See telegram, Moser to Cobb, dated San Francisco, 1 Jan. 1917; Cobb to Moser, dated Seattle, 18 Jan. 1917; and Henry Fortman, President APA to Cobb, dated San Francisco, 17 Feb. 1917. University of Washington Archives, Accession No. 1595-6, Box 1, Folder 5. Webb described the intricacies of Cobb's negotiations with APA (footnote 1).

[28] Cobb to Freeman, dated Seattle, 26 Jan. 1917, "am severing my connections with you." Also, Freeman to Cobb, dated Seattle, 21 Feb. 1917. Freeman gave his blessings to Cobb's departure, recommending that Cobb take the job but that "[Cobb] can always return to Pacific Fisherman." University of Washington Archives, Accession No. 1595-6, Box 1, Folder 30. Freeman temporarily replaced Cobb as editor of the journal. In the July 1917 issue of the magazine, Steadman H. Gray was listed as editor.

[29] Cobb kept personal diaries, as well as other records, of his years with APA. University of Washington Archives, Accession No. 1595-6, Boxes 8 and 10.

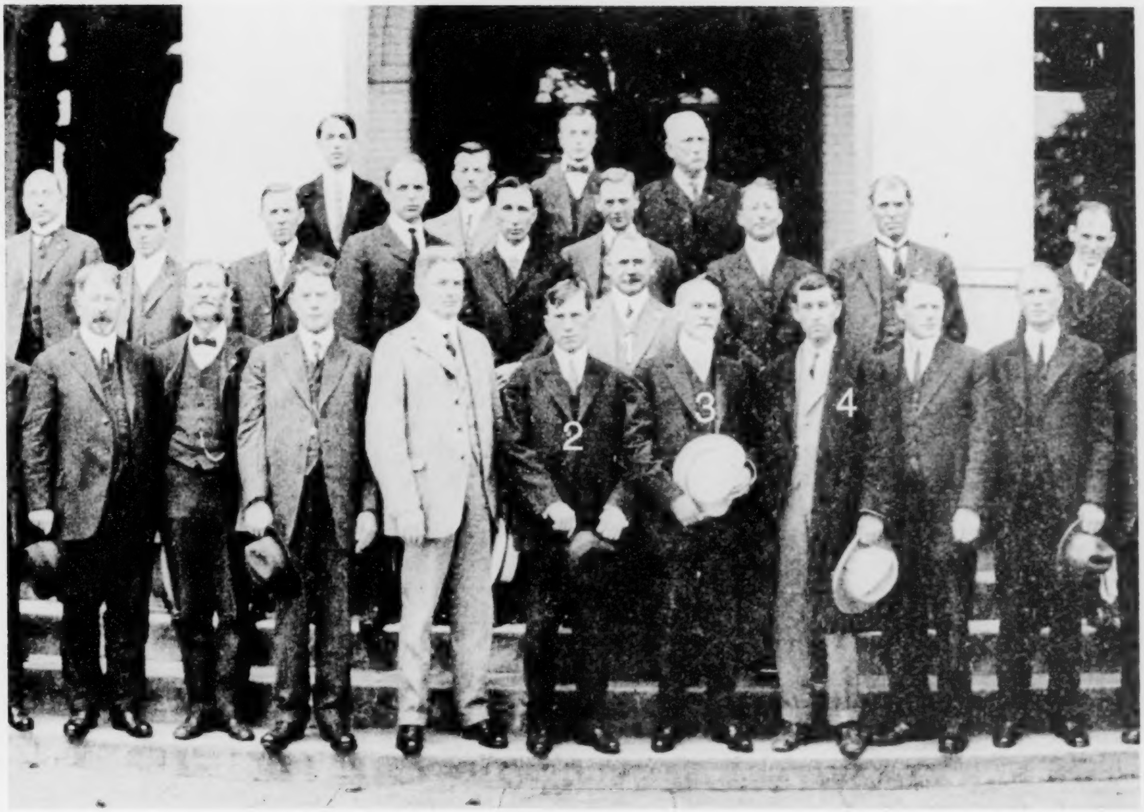


Figure 5.—Attendee's at the first Pacific Fisheries Society Meeting, held in Seattle from June 10–12 1914. 1) John N. Cobb, 2) Miller Freeman, 3) Hugh M. Smith, and 4) Trevor D. C. Kincaid. *Pacific Fisherman*, 1914, 12(6):11.

the forefront of a burgeoning movement to establish a "school of fisheries" at the University of Washington. He was not an unwitting observer of this movement. Indeed, he kept his name always fresh to the University administration and the result was that Cobb resigned from APA in January 1919 to accept the founding directorship of the College of Fisheries at the University of Washington.[30] This new position would serve him well and allow him to use his diverse talents in the fisheries field.

The Founding of the College of Fisheries at the University of Washington

The origin of the idea of a fisheries school at the University of Washington is unknown, but Miller Freeman likely played a vital role in the establishment of this new College. Richard Van Cleve (1906–1984), a longtime Dean of the renamed College of Fisheries who served from 1948–1971, ascribed the establishment of the College of Fisheries to Freeman.[31]

Freeman, in a letter dated 1937 to the U.W. President Lee Paul Sieg (1879–1963), wrote in part, "I call your attention to the fact that I secured the establishment of the School of Fisheries at the University of Washington. . . ."[32] In his memoirs, Freeman wrote that he used the editorial pages of *Pacific Fisherman* to advocate the establishment of a school

[30] Cobb to Henry F. Fortman, dated San Francisco, 31 Jan. 1919, "The President and Board of Regents have elected me to the position of Director of it." Fortman gave his blessing to Cobb's request, writing "With your qualifications, the directorship of the College of Fisheries at the University of Washington will give you a superior scope of endeavor and enable you to greatly further the development of the Pacific Coast fisheries." Fortman to Cobb, dated San Francisco, 8 Feb. 1919. University of Washington Archives, Accession No. 1595-6, Box 1, Folder 5. Cobb maintained good relations with APA during his leadership of the College of Fisheries.

[31] Van Cleve, R. 1984. History of the College of Fisheries. Unpubl. manuscr., Archives, School of Aquatic and Fishery Sciences, RS 3.3.1, "Flagship papers." Van Cleve. For additional information on Van Cleve, see Stickney (1989).

[32] School of Aquatic and Fishery Sciences Archives, RS 3.3.1, "Flagship Papers," photocopies.

of fisheries at the U.W. beginning in 1914 and that, after the conclusion of World War I in 1918, he resumed his lobbying to the U.W.[21]

Seattle became a "boom town" in the period 1900–1920. The city's population grew from about 81,000 in 1900 to become a major city of some 315,000 people by 1920. Many of Seattle's major establishments and various aspects of the city's civic development began during this period (Berner, 1991). Shipbuilding and metal trades were noteworthy components of the local economy in the years before World War I. The processing and transportation of lumber and wood products were important to Seattle and the greater Puget Sound region.

Both forestry and fisheries were important industries for the State of Washington in the first quarter of the 20th century and were of considerable interest to the U.W. Commercial fisheries in Washington State during 1914–1921 were highly dependent on harvest of Pacific salmon, whose catches fluctuated yearly. From 1914 to 1917, fisheries products in Washington State ranged in value from $1.7 to $15.2 million (Giles, 1918). According to Darwin (1921), the value of canned salmon in 1919–1920 was $12.9 million and in 1920–1921 it was much smaller, just over $4.5 million. Lumber production was the leading industry of the State during the first quarter of the 20th century; its value ranged from $37.1 to $68.8 million from 1907–1912, and was $41.8 and $53.2 million in 1915 and 1916 (Giles, 1918).

Fisheries, mainly for salmon, were of significant importance to Seattle. By the 1900's, over a million cases of salmon were packed in Puget Sound and about 5,000 men were employed in fisheries work in Seattle. By 1911, most of the fish packers in Alaska were headquartered in Seattle. They handled some 100,000 tons of fish products annually (Berner, 1991).

The University of Washington was also undergoing a major period of growth during 1900–1920. Faculty numbers grew from 33 in 1902 to 194 in 1913. Enrollment increased from fewer than 200 students in 1898 to over 700 in 1903–1904 and to more than 3,300 in 1913. The campus expanded with new buildings. The University's first marine laboratories, the Puget Sound Biological Laboratories, were established at Friday Harbor, Washington, in 1904 (Gates, 1961; Berner, 1991). As early as 1912, the U.W. Zoology Department was conducting research on the commercial fishing industry.[33]

The stimulus to action by the U.W. in developing a school of fisheries was provided in 1913 by Bureau of Fisheries Commissioner Smith (Stickney, 1989).[34] Smith submitted a paper to the Annual Meeting of the American Fisheries Society in Boston, Mass., titled "The Need for a National Institution for the Technical Instruction of Fisherfolk" (Smith, 1914).[35] Smith argued that technical education in the U.S. was lacking for fishermen, processors, and those involved in conservation of resources. He urged that this void be filled.

Smith's paper makes clear that he was primarily interested in educating the commercial fishermen in the ways of his industry, as opposed to educating people to become fishery scientists: "[instruction for] improvement of methods of taking, handling, preserving, and utilizing water products." He offered "A tentative plan for an institution for the imparting of practical technical instruction to American fisherfolk…" Smith, however, also advocated instruction "To become technical experts in the administration of the fishery services of nation or state" and "To engage in or take charge of national or state fish-cultural work" (Smith, 1914).

Smith felt that Seattle was the ideal place for such a school. He therefore wrote the Acting President of the University of Washington, Henry Landes (1867–1936) in February 1914:

> "I take liberty to bring to your attention the great desirability of establishing at the University of Washington a school of fisheries, or at least a comprehensive course in fisheries, having for its object the equipping of young men and young women for practical work in the service of the federal government, the various states, and private establishments having to do with artificial propagation, the curing and marketing of fishery products, and the administration of the fishing industry."

Smith further commented on the extensive need for trained people and the lack of qualified workers for the technical aspects of fisheries. He noted that training of "fisherfolk" was a neglected area, and suggested that Seattle was an ideal place for such a school due to its importance to the fishing industry of the Northwest.[36]

Landes quickly responded to Smith, writing that "This is a matter which has already received serious consideration at our hands and I think we will be able to follow out some such scheme in the Northwest." Landes mentioned offering a course in ichthyology in the Department of Zoology, but he concluded "We find, however, that it will soon be necessary to pay more attention to the economic phase of the question and to offer much more than we are now giving."[37]

In March 1914, Professor Trevor Charles Digby Kincaid (1872–1970),

[33] The Department of Zoology reported to the Board of Regents Annual Meeting of 1912 "One member of the department staff has spent considerable time in making a study of the fishing industry in this section." University of Washington Archives, Board of Regents Annual Meeting, 28 May 1912, Reports: Zoology (p. 3, item 2), Accession No. 78-102, Box 19, Folder 2. The Departmental report to the Regents the following year noted that Professor Victor E. Smith's research was on "Investigations of the fishing industry." University of Washington Archives, Board of Regents Annual Meeting, 28 May 1913, Zoology (p. 71), Accession No. 78-103, Box 19, Folder 4.

[34] Stickney (1989) provides further information about the founding of the College.

[35] Smith was an ichthyologist who directed the U.S. Bureau of Fisheries from 1913 to 1922 (Hildebrand, 1941; Anonymous, 1968). He was not able to attend the Boston meeting, so his paper was read by George W. Field.

[36] Hugh M. Smith to U.W. President [Henry Landes], dated Washington, D.C., 19 Feb. 1914. University of Washington Archives, U.W. Presidents Office Records, Accession No. 71-14, Box 122, Folder 5.

[37] Acting President [Landes] to Smith, dated U.W., 27 Feb. 1914. University of Washington Archives, U.W. Presidents Office Records, Accession No. 71-14, Box 122, Folder 5.

Chairman of the Department of Zoology, U.W., submitted a report to President Landes "on the advisability of establishing a School of Fisheries."[38] In this 10-page report, Kincaid provided a rationale for establishing such a school, noting that said training was not available in the United States. He briefly discussed schools elsewhere in the world that gave instruction in "fisheries classes," and indicated that "the only fully equipped school of fisheries in existence is the Imperial Fisheries Institute of Japan (Kincaid, 1915)."[39] Kincaid suggested subjects that could form the fisheries curriculum.[40]

Kincaid's proposed curriculum included subjects then offered at the U.W. that could be incorporated into a fisheries program; subjects not then offered, but which the present staff could readily offer; and "subjects demanding additional instructional assistance," such as pisciculture, fisheries products, technology, markets, and administration. His program emphasized training in applied or commercial aspects of the fishing industry rather than a scientific approach to fisheries by teaching biology and other sciences.[41]

Kincaid suggested that the course schedule should be established on a 2-year basis. The first year, he wrote, ought to be of a general character and the second year should allow specialization along two or more lines. Kincaid included a diagram suggesting potential areas of specialization: pisciculture, technology, School of Commerce, and "executive."[38]

Landes forwarded Kincaid's report to Professor Edmund Meany, asking him to review the program of other fisheries schools in a presentation to the Alaska Salmon Canner's Association meeting on 13 March 1914. Landes indicated that the U.W. was contemplating initiating a 2-year course as outlined by Kincaid, beginning the following year. If the reception to this course was good, then Landes thought the University might later expand the offerings to a 4-year curriculum.[42]

At the inaugural meeting of the Pacific Fisheries Society in 1914, Professor Kincaid read a paper describing the proposed school of fisheries at the University of Washington (Kincaid, 1915). At the conclusion of Kincaid's talk, the Society passed a resolution calling for "the establishment of a Department of Fisheries in the College of Science in said institution" (Anonymous, 1914d). Bureau of Fisheries Commissioner Smith, who also addressed the Society, endorsed such a school: "...I would expect that a tremendous boon to the fish industry of the entire country would be given by a fisheries school such as this if established here" (Kincaid, 1915).

Plans were then laid by the U.W. to begin instruction in fisheries in the Department of Zoology in the fall of 1914. Landes wrote Cobb that the U.W. would present a proposal for establishing a fisheries department to the Board of Regents in July 1914. He further informed Cobb that the U.W. would be able to start instruction soon, but it might be 1 or 2 years before the University could obtain the necessary money to cover later years of the course.[43]

The concept of a "fisheries school" at the U.W. was heartily endorsed editorially by *Pacific Fisherman*. The journal announced in their June 1914 issue that the U.W. was to open a fisheries school that fall, with a 4-year program (Anonymous, 1914b). The journal credited Kincaid and Smith as the impetus behind the establishment of the School (Anonymous, 1914e). The local and national press gave a favorable reception to this concept (Anonymous, 1914f, g).

The possibility of such a school was actively reported by the *Pacific Fisherman* in articles likely written by Cobb. In the October 1914 issue, the magazine announced the "first School of Fisheries in the United States." Rather than a "school" of fisheries, as previously reported, the magazine indicated that the course would for the present be taught in the Department of Zoology. The journal indicated that Kincaid had outlined a different program of study to embrace fisheries and that three students had already enrolled in these classes (Anonymous, 1914e). The U.W. course catalog for 1915–1916 listed courses in ichthyology and in pisciculture as offerings of the Department of Zoology. Ichthyology (Zool. 11, 12, for 2 credits each) was to be taught by Kincaid, and Smith was listed as the instructor for Pisciculture (Zool. 107, 108, 2 credits each).[44]

The insecurity caused by World War I apparently delayed the establishment of the fisheries school (Stickney, 1989; Webb unpubl.[1]). Evidence suggests, however, that planning for the school continued (Anonymous, 1915), and its establishment was supported editorially

[38] Kincaid to Landes, dated U.W., 5 Mar. 1914 (with report). University of Washington Archives, Trevor Kincaid papers, Accession No. 71-34, Box 122, Folder 5.

[39] Kincaid reported that some European countries offered training in oceanography and marine biology or certain aspects of fisheries. Examples mentioned were the Fish Cultural Laboratory, University of Grenoble, France, at the Universities of Kiel and Berlin, in Germany, and at the Biological Station, Bergen, Norway. Various marine biology and oceanography research laboratories in England, Scotland, and Ireland also offered limited training.

[40] This report was most likely prepared by Kincaid at the request of President Landes. Kincaid also indicated that commercial fisheries of the U.S. were then worth some $70 million. Kincaid to Landes, dated U.W., 5 Mar. 1914 (with report). University of Washington Archives, Trevor Kincaid papers, Accession No. 71-34, Box 122, Folder 5.

[41] Scientific investigation of the U.S. fisheries was in its infancy in this period. Pietsch and Anderson (1997) provide a history of ichthyology, and Smith (1994) reviewed historical aspects of fisheries research. Kincaid to Landes, dated U.W., 5 Mar. 1914 (with report). University of Washington Archives, Trevor Kincaid papers, Accession No. 71-34, Box 122, Folder 5.

[42] Landes to Meany, dated U.W., 7 Mar. 1914 (with Kincaid's report). University of Washington Archives, Accession No. 71-34, Box 122, Folder 5. Edmund Stephen Meany (1862–1935) was a well-known historian of the Northwest and a U.W. professor. He was also interested in natural history and was one of the first in the Northwest to lecture on Forestry; he is considered the "Father of U.W. Forestry." A brief history of the U.W. College of Forest Resources is located at http://www.cfr.washington.edu/about/history.html.

[43] Landes to Cobb, dated U.W., 16 June 1914. University of Washington Archives, Accession No. 71-34, Box 122, Folder 5.

[44] U.W. Course Catalog for 1915–1916, p. 204–205. University of Washington Archives.

in the *Pacific Fisherman* (Anonymous, 1916). Evermann (1917) called for government supported fishery experiment stations to conduct research of value to the commercial fishing industry, keeping the general subject alive in the pages of the *Pacific Fisherman*.

Cobb became more visible in the Northwest fisheries and conservation scene and maintained contact with the U.W. administration (Stickney, 1989).[45] He was apparently considered for membership in a proposed committee to search for a director of the new fisheries school.[46] Cobb likely was an early candidate for the position of director of the proposed school.

Cobb wrote a letter to Henry Suzzallo (1875–1933), President of the University of Washington, on 23 June 1916.[47] His 13-page letter began "In compliance with your personal request of some time ago, I submit herewith an outline of a general plan for a Fishery School at the University, and a part of the equipment of same." In a carefully crafted letter, he emphasized his knowledge of what a fisheries school should be. Cobb began with a justification for the proposed school and included a letter from Commissioner Smith to Cobb, supporting the establishment of such a school.[48] Cobb listed a number of items to be considered, including possible subjects to be taught: preparation of fishery products, laboratories, fishery products, navigation, engineering, shipyard boat building, workshops, and museum.

As World War I came to a close in November 1918, planning for a school of fisheries at the University of Washington continued at a more rapid pace. In October 1918 President Suzzallo wrote Cobb that through Miller Freeman he had heard that Cobb "might like to participate in the organization of such a school as a member of this faculty." Suzzallo was most concerned about the salary Cobb would require, noting that "Until this year our maximum salary has been $3,000."[49]

Cobb responded to Suzzallo on 26 December 1918 with his application for the position of director, and he noted that he had merely a common school education. He listed some 35 publications on fisheries topics in his application.[50]

Suzzallo answered Cobb on 4 [January?] 1919, appointing him Professor of Fisheries, administrative head of the Department of Fisheries, and Director of the College of Fisheries, at a salary of $4,000 per year. Cobb's initial appointment was for a 4-year period.[51]

Suzzallo recommended to the Board of Regents on 17 January 1919 that a College of Fisheries be established at the University of Washington. The Board agreed and the establishment of the College was authorized.[52] This event was duly reported in the *Pacific Fisherman* (Anonymous, 1919a).

Cobb as Director of the College of Fisheries

Cobb began the new College on a fast track. In an announcement for the College of Fisheries issued in early 1919, Cobb wrote that so much interest was generated by the announcement of the establishment of the College that "Professor Cobb, the Director, is open [sic] it for the coming spring quarter, March 31st, instead of waiting until the beginning of the fall quarter as originally planned." The announcement indicated the College would offer a 4-year course of instruction in Fish Culture and Fisheries Technology, and briefly described the potential job market for graduates. The announcement further stated that the College would, so far as possible, "assist students in securing employment during summer vacations" in various aspects of the fishing industry, hatcheries, and elsewhere.[53] The inauguration of the new College duly received wide and positive coverage in the press (Anonymous, 1919b, c). Commissioner Smith was quite pleased with the new College, writing in a glowing review: "The recent establishment by the University of Washington of a college of fisheries is of such importance as almost to mark an epoch in the history of technical education and in the development of the fishing industry in America" (Smith, 1919).

The new College apparently began life housed in two temporary wooden buildings along the Lake Washington Ship Canal at the southern margin of the U.W. campus (Anonymous, 1919a, c; Smith, 1919). The College soon relocated to other "temporary" housing located just north of the present U.W. Medical Center, where it remained until new quarters were built in the early 1950's (Cobb, 1920; Stickney, 1989).[54]

[45] Cobb submitted a proposal to the U.W. [n.d., but *ca.* 1916] for research on fish products. He offered to act as a consultant at no cost to the U.W. to supervise a graduate student who would conduct the work. University of Washington Archives, Accession No. 1595-6, Box 12, Folder 2. I could not find records of the fate of this proposal.

[46] Theodore Christian Frye (1869–1962), Dean, College of Science, to President Suzzallo, dated U.W., 22 Dec. 1915. Frye suggested that Suzzallo arrange a meeting between Cobb, the Secretary of the [Seattle] Chamber of Commerce, the Secretary of the [Seattle] Commercial Club, "the man whom you select as temporary head of the fish work, and yourself and myself if possible, to discuss define plans." This "should be done at once [orig. emphasis]. University of Washington Archives, Accession No. 71-34, Box 122, Folder 5. I was unable to determine whether or not such a committee was established.

[47] Cobb to Suzzallo, dated *Pacific Fisherman*, 23 June 1916. University of Washington Archives, Accession No. 1595-6, Box 2, Folder 21.

[48] Smith to Cobb, dated Washington, D.C., 4 Dec. 1914. University of Washington Archives, Accession No. 1595-6, Box 2, Folder 21.

[49] Suzzallo to Cobb, dated U.W., 24 Oct. 1918. University of Washington Archives, Accession No. 71-34, Box 122, Folder 5. Freeman (footnote 21) wrote that in 1918 he recommended Cobb to President Suzzallo for the directorship of the proposed school.

[50] Cobb to Suzzallo, dated San Francisco, 26 Dec. 1918. University of Washington Archives, Accession No. 1595-6, Box 2, Folder 21.

[51] Suzzallo's letter is dated 4 June 1919, but that date does not make historical sense. The College, under Cobb's direction, began in the spring quarter, on 2 Apr. 1919 (Stickney, 1989). See Suzzallo to Cobb, dated U.W., 4 June [?] 1919. University of Washington Archives, Accession No. 1595-6, Box 2, Folder 21.

[52] University of Washington Archives, Accession No. 1595-6, Box 2, Folder 21. The Regents established an advisory board for the College on 15–16 Dec. 1919. University of Washington Archives, Board of Regents papers, Accession No. 78-103, Box 21-3, 1919 Jan–Dec.

[53] "The College of Fisheries." School of Aquatic and Fishery Sciences Archives, "Flagship Papers," RS. 3.3.1, No. 3 "photocopies."

[54] A good description and photographs of the original buildings and facilities of the new College appear in the June 1919 issue of *Pacific Fisherman* (Anonymous, 1919c).

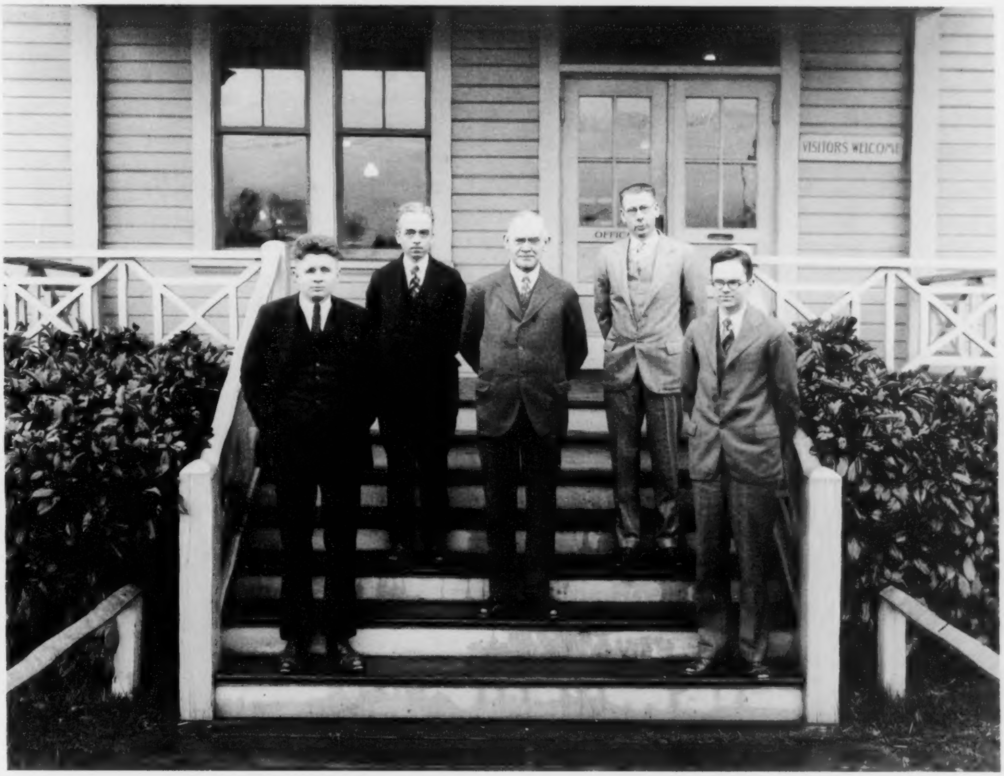


Figure 6.—Faculty of the College of Fisheries, 1929. Left to right, Norman Jarvis, Donald Crawford, John Cobb, Clarence Parks, and Leonard Schultz. University of Washington Archives, U.W. 15484.

The initial faculty was composed of Cobb and two newly hired instructors: George C. Embody, who received his Ph.D. degree at Cornell University, taught courses in Fish Culture, and Clarence L. Anderson, who had recently earned his B.S. degree from the U.W., was mainly responsible for courses in Fisheries Technology. Trevor Kincaid of the Zoology Department taught Ichthyology (Stickney, 1989).[55]

Cobb taught, at various times, Introduction to Fisheries, Fishery Methods, Fishery Problems, and History of Fisheries.[56] During Cobb's directorship, the faculty remained small and underwent considerable turnover, likely caused in part by the low salaries paid to instructors. The number of faculty listed in course catalogs from 1919–20 to 1929–30 ranged from two to five, including Cobb (Fig. 6).[57] Numerous "Associated Faculty," drawn from other U.W. departments or from industry or government agencies were listed in the Colleges entry in U.W. Course Catalogs. An Advisory Board composed of 11 individuals from the commercial fishing industry, including Miller Freeman, and from state and federal fisheries agencies was listed in the 1919–1920 course catalog. Most of the faculty in the College were educated at the University of Washington, in whole or part, which resulted in a lack of diversity in faculty training, a problem that plagued the College for about 50 years.[58]

[55] The first U.W. Course Catalog that listed the College of Fisheries was issued for the 1919–1920 academic year. The Catalog indicated that the College offered B.S. and M.S. degrees and listed 12 courses offered, as well as six "short courses." University of Washington Archives. Stickney (1989) provides biographical information about professors during Cobb's era.

[56] University of Washington Archives, Accession No. 1595-6, Box 15, Folders 4-8, and Box 16, Folder 1. There are course outlines written by Cobb as well as other teaching materials in Cobb's papers.

[57] U.W. Course Catalogs, 1919–1930. University of Washington Archives. William Francis Thompson (1888–1965) wrote a history of the School of Fisheries in which he analyzed the course offerings of the College from 1919–1943. See Thompson, W.F. manuscr. [n.d.]. "History of the School of Fisheries." Typescript, variously paginated. School of Aquatic and Fishery Sciences Archives, RS. 3.3.1, "Flagship Papers." Thompson, a preeminent scientist of the era, succeeded Cobb as Director of the newly renamed Department of Fisheries in 1930 and served in that position until 1946. For more on Thompson, see Dunn (2002).

[58] U.W. Course Catalogs, 1919–1930. University of Washington Archives.

Cobb had trouble recruiting experienced faculty for the College. For example, he tried to entice Willis Horton Rich (1885–1972), a Professor at Stanford University and renowned researcher on salmon biology, to the U.W. without success, though, offering Rich $3,000 to head a proposed "Department of Fish Culture."[59]

The design of the curriculum largely followed that suggested earlier to the U.W. President by Professor Kincaid and previously outlined by Cobb.[38, 47] Two curricular tracks were initially established, fish culture and fisheries technology (Table 2). The two lines of inquiry were quite similar for the first two years, differing mainly in that the requirements for the technology major (Fig. 7) included twice as many chemistry credits as did the fish culture major. The number of fisheries courses offered increased from 12 in the initial year of the College to 24 in the academic year 1928–29 (Table 3).[60]

Enrollment in the College was strong during the first decade of its existence, ranging from 30 to 117 students a year (Table 4). The College initially offered Bachelor and Master of Science Degrees and, later, a Doctor of Philosophy Degree. The first graduating class in Fisheries was in 1922, with five B.S. degrees conferred as well as the first Ph.D. degree, awarded to Ray Clough, then on the College of Fisheries faculty. Identical numbers of degrees were apparently issued each year in 1923, 1924, and 1925. The first M.S. degree was awarded in 1924 to Clarence Anderson, also on the faculty of the College. During Cobb's reign as Director and Dean, there were 31 B.S. degrees granted (from 1919–20 through the 1928–29 academic years) as well as one M.A., eight M.S., and two Ph.D. degrees.[61] Thus, only about 42 students graduated during the first decade of the College.

Table 2.—Course offerings in Fisheries at the University of Washington, 1919-1920. (U.W. Course Catalog, 1919–1920, U.W. Archives).

Autumn Quarter	Credits	Winter Quarter	Credits	Spring Quarter	Credits
I. Fish Culture					
Freshman					
Zoology 1	5	Zoology 2	5	Gen. Embryology	5
Intro. to Fisheries 1	2	Intro. to Fisheries 2	2	Chemistry 3	5
Chemistry 1 or 21	5	Chemistry 2 or 22	5	Economics 1	5
English	3	English	3	Military Science	2
Military Science	2	Military Science	2		
Sophomore					
Ichthyology 3	5	Ichthyology 4	5	Aquatic Botany 53	5
Physics 47 or elective[1]	5	Physics 48 or elective[1]	5	Ichthyology 5	5
Elective	5	Elective	5	Pacific Fisheries 6	2
Military Science	2	Military Science	2	Elective	3
				Military Science	2
Junior					
Bacteriology 101	4	Bacteriology 102	4	Fish Culture 103	5
Fish Culture 101	5	Fish Culture 102	5	Fishery Methods 105	5
Plankton (Zool. 106)	5	Fishery Methods 104	5	Electives	5
Elective	2	Elective	2		
Senior					
Fish Culture Problems 107	5	Fish Culture Problems 108	5	Fish Culture Problems 109	5
Fish Diseases 117	5	Electives	10	Electives	10
Electives	5				
II. Fisheries Technology					
Freshman					
Zoology 1	5	Zoology 2	5	Economics 1	5
Intro. to Fisheries 1	2	Intro. to Fisheries 2	2	Chemistry 3	5
Chemistry 1 or 21	5	Chemistry 2 or 22	5	Electives	5
English	3	English	3	Military Science	2
Military Science	2	Military Science	2		
Sophomore					
Org. Chemistry 37	5	Org. Chemistry 38	5	Quantitative Chemistry 101	4
Ichthyology 3	5	Ichthyology 4	5	Pacific Fisheries 6	2
Physics 47 or elective[1]	5	Food Laws (Phar. 16)	1	Ichthyology 5	5
Military Science	2	Physics 48 or elective[1]	5	Elective	5
		Military Science	2	Military Science	2
Junior					
Bacteriology 101	4	Bacteriology 102	4	Employment Management 167	3
Bus. Administration 120	3	Plant Management 195	3	Prep. Fishery Prod. 106	5
Fishery Methods 104	5	Fishery Methods 105	5	Biology of the Seas (Zool. 108)	3
Admiralty Law 165	3	Elective	3	Ec. Fish. Resources 115	3
Senior					
Fishery Problems 110	5	Fishery Problems 111	5	Fishery Problems 112	5
M. Engineering 92	3	Electives	10	Electives	10
Electives	7				

[1] If the student has taken one year of physics in high school he will substitute electives for Physics 47 and 48.

The courses offered remained similar during the first decade of the College's existence, with one notable exception. A new series of courses, not associated with fisheries, was started beginning in the fall of 1922. Seven courses on Fruit and Vegetable Preservation were offered that year. Carl R. Fellers was listed in the catalog as "Associate Professor of Food Preservation" and Ray W. Clough was listed as "Lecturer of Food Preservation." Bachelor of Science and Master of Science degrees were offered in Food Preservation, and a second option, "Commercial Canning and Curing of Fruits and Vegetables," was available as an academic major the following year. This option was labeled Food Processing instead of Fish Technology.[62]

[59] Cobb to Willis Rich, dated U.W., 7 Jan. 1922. University of Washington Archives, Accession No. 71-34, Box 122, Folder 6.

[60] U.W. Course Catalogs, 1919–1930. University of Washington Archives.

[61] U.W. course catalogs list the number and type of degrees granted during the years 1919–1929, but that practice was stopped in 1930. U.W. Course Catalogs, 1919–1930. University of Washington Archives. Total enrollment figures for the College are listed in Thompson manuscr. in footnote 57.

[62] U.W. Course Catalogs, 1922–1925. University of Washington Archives. A U.W. news item titled "College plans aid to fruit growers" was released by the University on 4 Mar. 1923. The release described the course offerings and extensively quoted Cobb. University of Washington Archives, Accession No. 1595-6, Box 23, Folder 5. An announcement and outline of the new course, titled "Commercial canning of fruits and vegetables," [n.d.] is present in University of Washington Archives, Accession No. 1595-6, Box 23, Folder 1. See also Thompson manuscr. in footnote 57.

Table 3.—Course offerings in Fisheries at the University of Washington during the 1929–30 academic year (Stickney, 1989).

Course no.	Title	Instructor
1, 2	History of Fisheries	Cobb
6	Pacific Fisheries	Cobb
50	Elements of Fisheries	Jarvis
53, 54	Ichthyology	Schultz
60	Aquatic Animals other than Fish	Schultz
65	Fishing Vessels and Boats	Parks
101–103	Fish Culture	Crawford
104, 105	Fishery Methods	Cobb
110	Fresh and Frozen Fishery Products	Jarvis
111	Curing of Fishery Products	Jarvis
112	Oyster and Clam Culture	—
115	The Economic Fishery Resources of North America	Cobb
120	Fundamentals of Canning	Parks
121	Canning Machinery and Cannery Management	Parks
122	Canning of Fishery Products	Parks
140	Aquarium Management	Crawford
145	Food Laws	Parks
147	Preparation of Secondary Products	Parks
150–152	Problems in Fish or Shellfish Culture and Fisheries Technology	Cobb and Staff
154	Diseases of Fish	Guberlet
175	Exploration of the Sea and its Relation to Economic Food Fishes	Cobb
190	Fishways and Fishtraps	Cobb
195–197	Seminar	Cobb and Staff

Table 4.—Enrollment in the College of Fisheries, 1919–1929 (from Thompson, manuscr., text footnote 57).

Year	Academic Year	Short Course
1919–20	76	36
1920–21	46	11
1921–22	30	17
1922–23	41	12
1923–24	51	16
1924–25	64	21
1925–26	67	5
1926–27	97	6
1927–28	117	6
1928–29	117	2

Figure 7.—Interior of lab at the College of Fisheries showing students at work, *ca.* 1920. University of Washington Archives, U.W. 15299.

The experiment in food processing and preservation was dropped in 1924. Clough was not listed in the Course Catalog after the 1922–1923 academic year, but Fellers continued to be listed as part of the College's faculty until 1926–1927. Thus ended the College of Fisheries initial relationship with food processing, a subject area that was to return to the School in the late 1940's.[63]

The College immediately upon opening began offering "short courses" for the benefit of fishermen, processors, and hatchery personnel. These were apparently offered each winter from 1920 to 1929.[64] The courses were intended to be "practical," offering instruction on Bacteriology of Foods, Diseases of Fishes, Navigation, Operation of Gas Engines, and First Aid. Attendance in these courses was relatively modest in the first few years, ranging from 11 to 36 registrants each year. After 1925, however, attendance dropped off, averaging only five or six students with only two registrants listed in 1929.[65] The attendance indicates that the demand for such instruction, or the quality of

[63] A food science program was reinstated in the School of Fisheries in 1947 and remained an option for a major for about 45 years. The program was phased out in 1992. Gary Pedersen, Administrator, School of Aquatic and Fishery Sciences, personal commun., 17 Nov. 2003. For additional information about the history of food processing technology offerings of the School of Fisheries, see Stickney (1989).

[64] The draft history of the College of Fisheries by Thompson provides enrollment figures of short courses indicating they were held each year from 1920–1929. Thompson manuscr., footnote 57. The draft history of the College written by Van Cleve, however, states that these short courses were offered annually for seven years and then dropped. Van Cleve manuscr. in footnote 31.

[65] Thompson manuscr. in footnote 57.

the courses, was not as sufficient as had been hoped.

Cobb decided to offer a summer course in ichthyology in 1922 at the Puget Sound Biological Laboratories, at Friday Harbor, Wash. He sought funding for this course ($400 for "1 professor of ichthyology and $75 for 1 laboratory assistant"), but was told that the summer session at the Station was not financed as part of the regular summer session of 1922. He was advised to seek financing from the station director, Theodore. C. Frye. Apparently the intended course was not offered.[66]

In the late 1920's Cobb felt the need for additional and improved facilities for the College. He was a strong advocate for the expansion of the College, making requests to various administrative deans for new space. Cobb was largely unsuccessful in these expansion efforts, although he acquired a 29-foot launch, the *Salmonidae*, and a 5-horsepower motor in 1927.[67]

Cobb vigorously promoted the College in a variety of ways. As a former newspaperman, he ensured that many articles were published in the local press. The College was also the subject of attention in the national and international print media.[68] As Dean, he was the subject of a number of profiles in various newspapers and magazines.[69] Cobb published several articles about the College (Cobb, 1920, 1921, 1928a, b, c), and he gave talks about fisheries to various clubs and organizations in Seattle as well as towns in outlying areas.[70] Cobb was also active in the community, holding membership in the Arctic Club of Seattle[71], the Puget Sound Academy of Science, and the Aquarium Society of Seattle, where he served as founding president.[72] All of these social engagements served as a focal point for the College and for Cobb.

A "Fisheries Club" was established at the College (Fig. 8). Meetings of the Club served as a way for students to meet those in the fisheries industry and "smokers" were hosted that were funded by the fishing industry (Anonymous, 1920). Annual banquets of the Club were also held.[73]

Because of his publications on Pacific salmon and Pacific cod (Cobb, 1911, 1916b, 1917), as well as his other fisheries papers, Cobb was known as a fine "statistician." He was apparently an accurate compiler of fishery statistics. Charles Henry Gilbert (1859–1928) of Stanford University, the preeminent Pacific salmon expert of the era, recommended in 1919 that the U.S. Bureau of Fisheries contract with Cobb to develop a statistical system to record catches of Alaska salmon:

> "I need say nothing to you concerning the qualifications of Professor Cobb, who was long an efficient agent of the Bureau. No one is better informed on all phases of the salmon fisheries of Alaska, no one enjoys more completely the confidence of the cannery men, and no one with whom I am acquainted is a more reliable statistician."[74]

While Dean, Cobb undertook work for his former employer, the Alaska Packers Association (APA). He provided APA yearly salmon pack estimates and other information to the company from 1920–1929. Cobb apparently did not want his consulting work to be known to the U.W., as his letters to APA were marked "confidential" and the Association sent letters to Cobb at the latter's private residence.[75]

Cobb apparently had a reputation as possessing a "strong personality" (Stickney, 1989).[76] He apparently antagonized the faculty, but the latent hostility of the professors did not surface until Cobb's incapacitation in 1929. In a 10-page memorandum titled "Confidential: Conditions at the College of Fisheries" and signed, "Staff," the authors laid out a series of complaints against the Dean.[77] The authors wrote that the College had lost prestige, mainly since 1925, due to the Dean's activities. They detailed Cobb's work on passage of salmon over dams when he was unqualified to do so because he lacked training as a scientist and was neither a biologist nor an engineer. The writers criticized the self-promotion of the College, asserting that much of it was false. The complaints continued: faculty meetings had never been held in the College; the College's library was

[66] Cobb to F. E. Bolton, Director of Summer Quarter, dated U.W., 8 Nov. 1921. Bolton to Cobb, dated U.W., 12 Nov. 1921. University of Washington Archives, Accession No. 74-6, Box 19, Folder 2, Schedule Committee. Ichthyology was not listed in the U.W. course catalogs for the Puget Sound Biological Station at Friday Harbor from 1922–1930.

[67] For example, see Cobb to Deans David Thompson and F. M. Padelford, dated U.W., 9 Apr. 1929. University of Washington Archives, Accession No. 1595-6, Box 5, Folder 2, outgoing letters 1905–1929. See also footnote 87. It is unclear how the launch was obtained. University of Washington Archives, Accession No. 1595-6, Box 21, Folder 5.

[68] There are literally hundreds of newspaper clippings about the College and fisheries in the Cobb papers. See University of Washington Archives, Accession No. 1595-6, Box 20, Folder 6; Box 21, Folders 1–10; Box 22, Folders 1–7; and Box 23, Folders 1–6.

[69] University of Washington Archives, Accession No. 1595-6, Box 1, Folder 1; Box 21, Folder 1; and Box 22, Folder 4, among others.

[70] For example, Cobb gave 27 talks to various audiences during 1927. University of Washington Archives, Accession No. 1595-6, Box 1, Folder 1.

[71] University of Washington Archives, Accession No. 1595-6, Box 2, Folder 22. "A" 1914–1927.

[72] University of Washington Archives, Accession 74-6, Box 2, Folder 22.

[73] "Smokers" were get-togethers of students, faculty, and industry or governmental personnel, for food and entertainment (and, likely, the smoking of cigars). On 4 Mar. 1927, the Fisheries Club held its seventh annual banquet in the main dining room of the L. C. Smith Building in downtown Seattle. Seven commercial fishing companies made contributions to the costs. Ten speakers were featured, including Professors Cobb and Kincaid. University of Washington Archives, Accession No. 1595-6, Box 9, Folder 1. Cobb diary for 1926–1927, p. 70, dated 4 Mar. 1927.

[74] Gilbert to Henry O'Malley, dated Stanford, 4 Oct. 1919. National Archives Record Group 22, U.S. Fish and Wildlife Service, Entry 91. Records and Reports of the Division of Alaska Fisheries, File 56, Correspondence of Gilbert and O'Malley, 1919. Gilbert's recommendation was apparently not accepted by the Bureau. For more on Gilbert, see Dunn (1997).

[75] APA paid Cobb $500 a year from 1920–1929 to provide the Association with salmon pack statistics by cannery for all of Alaska. University of Washington Archives, Accession No. 1595-6, Box 1, Folders 6 and 7 and Box 3, Folder 4.

[76] Stickney (1989) gave examples of Cobb's "strong personality."

[77] University of Washington Archives, Accession No. 71-34, Box 122, Folder 6. The memorandum is undated, but was likely written in the Fall of 1929, as Cobb died on 13 Jan. 1930. The first page of the memorandum contains an additional sub-heading "The following are in no way to be considered as charges—no proof is offered—, merely opinions as to causes of a condition commonly known to exist."

Figure 8.—Fisheries Club, 1921. Cobb is in the top row, fifth from right. University of Washington Archives, Cobb negative no. 15485.

primarily for the personal use of the Dean; suggestions by faculty or students for new courses or improvements to the offered courses were ignored by the Dean; student scholarships were not available; equipment purchases were made solely by the Dean and were poorly chosen; and the faculty was discouraged and unhappy. The summation of this memorandum listed the actions taken by the faculty to correct these faults in the absence of Dean Cobb. Whether or not this note was shown to the next Director is not known.

Cobb and Research at the College

After spending some time in the University system, Cobb became aware that the College was not held in high esteem by many of his colleagues, likely because of its applied emphasis and lack of scholarly endeavor. Cobb initiated three actions possibly designed to counter some of this criticism. In 1924 he began a research program on the passage of salmon over dams in which he was the sole investigator, he initiated in 1925 a journal of the College titled "*U.W. Publications in Fisheries,*" and he hired a trained ichthyologist to teach and conduct research.

What became the first major battle of "fish v. dams" in the Pacific Northwest arose in 1924, when the Priest Rapids hydroelectric dam was proposed for the main stem of the Columbia River in eastern Washington. Cobb became the initial spokesman for the opposition, working with the directors of the fish and game agencies of Oregon and Washington, the salmon canners, sportsmen, and others opposed to the blocking of anadromous runs of Pacific salmon (Cobb et al., 1924).[78] This was the era before the advent of the "environmentalists," and

[78] Henken (see footnote 2) reviewed the background of the Priest River controversy and Cobb's venture into fish passage research. The account presented here is largely based on Henken's manuscript. Cobb earlier reviewed some of the problems inherent in protecting migrating salmon (Cobb, 1922).

the opposition to hydroelectric dams on major rivers in Oregon and Washington was led mainly by those affiliated with commercial fisheries. According to Mighetto and Ebel (1994), "During the 1930's, relatively few Northwesterners objected to the construction of hydroelectric dams on the Columbia River. Vehement protests of large-scale dams would emerge in later decades." Robbins (1996) wrote that "As a group, the constituencies opposed to the dams were overwhelmed and politically impotent compared to the massive influence of metropolitan chambers of commerce, development interests, public power advocates, farmers, and a panoply of other promoters."[79]

Cobb, at first, was strongly opposed to the construction of these dams, but the Chairman of the U.W. Engineering Department apparently convinced him that passage of fish over high dams was feasible. If such passage was possible, then cooperation with those advocating hydroelectric projects could lead to fish passage facilities and, hopefully, ensure that the salmon resource would not be adversely impacted.[80] The companies involved in constructing the proposed dam would likely finance the required research on fish passage.

Cobb arranged for a conference on the subject of fish passage over high dams to be held at the U.W. in May 1924. The conference resulted in the formation of a committee composed of Cobb and representatives of the Oregon Fish Commission, the Washington State Fisheries Commission, and three members of the Northwest Electric Light and Power Association (NEPL), whose task was to plan research operations and a formulate a budget to carry out the investigations. This Committee subsequently placed Cobb in charge of the fish passage research. A budget of $5,000 was devised with the NEPL responsible for 50% of the costs and the Oregon and Washington fisheries agencies splitting the remainder of the budget.[81]

Thus Cobb, with great confidence, but without education in the scientific method, with little knowledge of the biology of salmon, and lacking a background in engineering, decided to devise a method of passing salmon over dams. He approached this task by designing a mechanical lift, based on a principal somewhat similar to an escalator, to lift salmon over dams.

Cobb intended to lift the salmon in a wire basket, without keeping them submerged in water, over the dam and drop them back into water on the upstream side of the dam; he apparently felt that the salmon could easily survive out of water for the time it would take to lift them. He did not, apparently, seek technical assistance either from engineers or biologists for his fish passage research. A Seattle firm was contracted to build the device.[2]

The lift was tested on 23–24 September 1924 at the 100-foot high Condit Dam on the White Salmon River in Eastern Washington (Fig. 9). Unfortunately, migrating salmon could not be enticed to enter the wire basket and, because of the murky water present, fish could not be detected when they in fact entered the basket (Fig. 10). Tests were repeated in 1925 with similar results. Salmon would not approach the basket, and Cobb's venture was a failure.[2]

Cobb published reports that generally gave a favorable view of his research on fish passage (Cobb, 1925a, b; 1927). He also included a brief and favorable summary of his fish passage research in his review of the activities of the College (Cobb, 1928a). Cobb early on was recognized by some as an expert in fish passage.[82] However, he was the subject of bad publicity in the newspapers and the committee formed to support his research dissolved in 1925 (e.g. Anonymous, 1924).[2]

Cobb's research on fish passage was also the subject of the first section of the memorandum of complaint by faculty of the College of Fisheries:[77]

> "In 1925 application was made for a permit to construct a certain high dam at which various agencies interested in the conservation of our fisheries, led by the Dean of the College of Fisheries, registered great protest. The Dean was placed in complete charge of the experimental work to find a means of insuring safe passage for the salmon over the dam, and while the problem was one for a biologist and engineer, no one from the College of Fisheries except the Dean, who is not a biologist, was allowed to participate in the work.
>
> "A preliminary report was issued carrying such evidence of success that the way was apparently paved for the issuance of a permit for the construction of the dam with a very low liability clause for damage to the fisheries. Local fishery interests resented deeply this right-about-face and apparent selling out of their cause and have but little to do with the College of Fisheries since.
>
> "Most of the experimental work performed has been termed a failure and is now resulting in the loss of a valuable salmon run. United States Commissioner of Fisheries O'Malley, Pacific Fisherman, Dr. Henry Baldwin Ward, biologist, have been free with criticism—the College of Fisheries Staff, who have had nothing to do with the matter, suffering with the institution."

In 1925, the College established an "in-house" journal named *University of Washington Publications in Fisheries*.

[79] Taylor (1999) reviewed the history of hydroelectric projects in Oregon and Washington and their relation to Pacific salmon.

[80] Henken (see footnote 2). Lichatowich (1999) described some of Cobb's opposition to the construction of high dams on the Columbia River. Cobb also was an early doubter of the efficacy of hatcheries as a panacea for salmon restoration (Lichatowich, 1996).

[81] Henken (see footnote 2). Cobb was also to be given a salary by the committee of $500 a month, plus expenses, to conduct the research, a sum larger than his monthly salary at the U.W. Apparently this fee was never paid and the Oregon Department of Fisheries had trouble paying its share of the research assessment.

[82] W. C. Leighton, Washington Irrigation and Development Company, to Cobb, dated Seattle, 24 May 1924: "In all of the conferences with the various engineers I have stated the arrangements that were made subsequent to the recent salmon conference at Seattle and given your name as foremost authority on the subject." University of Washington Archives, Accession No. 1595-6, Box 4, Letters concerning fishways, 1921–1929, Folder 11.

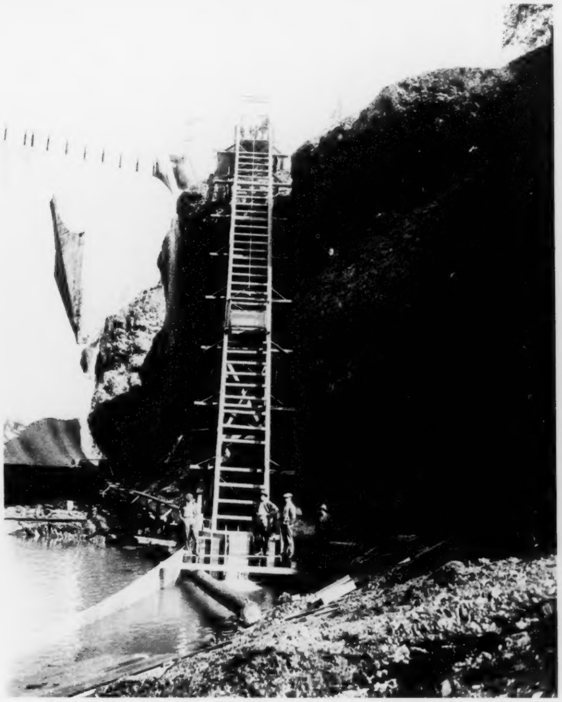


Figure 9.—Fish hoist [*ca.* 1924]. University of Washington Archives, John N. Cobb photographs, Collection no. 418, Box 5, Folder 183, print no. 5010.

Figure 10.—Fish passage basket [*ca.* 1924]. University of Washington Archives, John N. Cobb photographs, Collection no. 418, Box 5, Folder 183, print no. 5098.

The organ was issued in volumes and in 1927 a series of "Special Bulletins" was begun. Of the first 15 titles published, all by members of the College faculty, most dealt with the commercial aspects of the fishing industry.

In the late 1920's, Cobb planned to create a Department of Ichthyology that would be "separate" from the applied courses in the College. In 1927, he began to search for a qualified ichthyologist to teach, conduct research, and to begin a systematic fish collection in the College.[83] After a nation-wide search, Cobb selected Leonard Peter Schultz (1901–1986) whom Cobb had met in 1926.[84] Schultz had received an M.S. degree at the University of Michigan where he studied under the well-known ichthyologist Carl Leavitt Hubbs and, in 1927, was teaching zoology at the Michigan State Normal College at Ypsilanti.[85] Schultz was apparently planning to pursue a Ph.D. degree in ichthyology at the University of Michigan.[86]

Cobb hired Schultz in 1928 as an instructor with a salary of $2,500. Schultz was to teach ichthyology, another course to be called "Problems in Ichthyology" that he was to devise, and to participate in seminars. He was also expected to complete his doctoral degree, after which he would be promoted to assistant professor. Schultz moved to Seattle in the fall of 1928 and immediately began to teach and to assemble a research collection of fishes (Fig. 11).[84]

[83] Cobb to Schultz, dated U.W., 26 Apr. 1927: "I have in mind the development of a separate department of ichthyology (it is now combined with that of fish culture)…." Smithsonian Institution Archives, Leonard Peter Schultz papers, Record Unit 7222, Box 15, Folder 12.

[84] For a discussion of Cobb's plans about a "Department of Ichthyology," as well as additional information on the tenure of Leonard Schultz at the U.W., see Dunn (2003), "Seventy-five years a gathering: The University of Washington fish collection, 1928–2002." http://www.U.W.fishcollection.org/Geninfo/U.W.fc_history/Schultz.htm.

[85] Telegram, Cobb to Schultz, dated U.W., 10 May 1928: "Are you in position to consider offer of Ichthyology position College of Fisheries." See also Cobb to Schultz, dated U.W., 18 May 1928, and Schultz to Cobb, dated U.W., 24 May 1928. Smithsonian Institution Archives, Record Unit 7222, Box 15, Folder 12. Hubbs (1894–1979) became a preeminent ichthyologist of North America (Miller and Shor, 1997).

[86] Leonard Peter Schultz interview, 1976. Smithsonian Institution Archives, Record Unit 9510, p. 4. Schultz to Richard Van Cleve [n.d., but *ca.* 1980], Port Republic, Maryland. School of Aquatic and Fishery Sciences Archives, "Flagship" papers, Box 3.3.1, No. 3 "photocopies." Schultz completed his doctorate in 1932 in the U.W. Department of Zoology (Schultz, 1933). He remained at the U.W. until 1937, when he accepted a position with the U.S. National Museum, Smithsonian Institution, Washington, D.C., at an increase in salary.

Figure 11.—Ichthyology class, *ca.* 1920. Trevor Kincaid is standing to the right at the rear of the room. University of Washington Archives, U.W. 15345.

Dean Cobb and Schultz had great hopes for the future of ichthyology at the College. Schultz, as instructed by Cobb, planned new laboratories for the study of fishes as well as for storage space for the growing fish collection. In a 1928 proposal from the College for "Equipment for Proposed New Fisheries Building," Schultz asked for 4 tables and 25 chairs to accommodate 20 people in the "Library of the Ichthyology Department," in just one aspect of the initiative.[87] However, nothing became of these initiatives.

These activities were apparently sufficient to enable Cobb to remain as Dean of the College (Fig. 12). They were inadequate, however, to ensure the continuation of the College upon his demise.

The Demise of Cobb and of the College

John Nathan Cobb suffered from heart disease and endured a heart attack in the summer of 1929. He was ill for many months and spent his final days in the warmer climate of La Jolla, Calif., where he died on 13 January 1930 at the age of 61 (Schultz, 1930; Stickney, 1989). His death was prominently noted in local newspapers and in numerous fisheries publications.

Leonard Schultz (1930), in an obituary of Cobb, praised him for his work in establishing the College and noted his "concentration and unremitting effort that marked his career. . . ." The *University of Washington Daily* wrote of him as a "Leader" who had a "Brilliant Career" (Anonymous, 1930a). *Pacific Fisherman* called him "a firm friend and indefatigable worker for its [fishing industry] advancement (Anonymous, 1930b), and the *Fishing Gazette* called Cobb a "Fisheries Authority" (Anonymous, 1930c). A memorial service was held on the U.W. campus and Professor Henry Landes noted Cobb's "strong personality that influenced his students in a wholesome way and endeared him to those colleagues who knew him best."[88] His funeral was held in Seattle on 22 June 1930 at University Undertaking Parlors.

Shortly after Cobb's death, the new Governor, Roland Hill Hartley (1864–1952), fired U.W. President Suzzallo and replaced him with Matthew Lyle Spencer (1881–1969), the former Dean of the College of Journalism. Spencer sought scholarship and high academic standards at the U.W., and he did not think highly

[87] Schultz to Cobb, dated U.W., 12 Oct. 1928. University of Washington Archives, Accession No. 74-6, Box 23, Folder 28. Cobb argued to the U.W. administration for additional space for the Fish Collection "for storing our rapidly growing and valuable scientific collection of preserved specimens fishes [*sic*], and the housing of our research students in ichthyology." See also footnote 67.

[88] Statement by Henry Landes. Memorial Exercises, Meany Hall, 27 May 1930. University of Washington Archives, Accession No. 1595-6, Box 1, Folder 2.

Table 5.—Course offerings in the Department of Fisheries at the University of Washington during the academic year 1931–32 (Stickney, 1989).

Course no.	Title	Instructor
101, 102, 103	Systematic Ichthyology	Schultz
105, 106, 107	Commercial aquatic invertebrates	Schultz
125, 126, 127	Early life history of fishes	—
154	Diseases of fish	Guberlet
120	Exploration of the sea in its relation to fishes	—
157, 158	Later life history of fishes	Schultz
159	Conservation	Thompson
165, 166, 167	Elementary problems	Thompson, Schultz
195, 196, 197	Seminar	Staff
201, 202, 203	Research	Thompson
205, 206, 207	Graduate seminar	Thompson

Figure 12.—John N. Cobb [*ca.* 1920's]. University of Washington Archives, COB 181.

of the College of Fisheries. Apparently, courses in canning and fishing methods did not meet the new President's criteria of scholarship. As a result, the College was dissolved in April 1930 and all faculty of the College were dismissed, except for Leonard Schultz who was apparently considered a bona-fide academic and was assigned to a position in the new College of Science (Stickney, 1989).[89]

Uproar occurred among the students in the College who now faced a situation wherein they now had no major field. They sent a telegram to Governor Hartley protesting President Spencer's actions stating, in part, [your action] "Protested by unanimous action of fisheries students." Upon his inquiry of the U.W., Governor Hartley was told that the Board of Regents had created a new College of Science and had elected to consolidate the College of Fisheries as a Department in the new College (Stickney, 1989).[90]

A new Director was appointed for the Department in the person of William Francis Thompson (1888–1965), who was to become the dominant figure in the U.W. Department (later, School) of Fisheries for over 16 years and the preeminent fishery scientist of the Pacific Northwest for nearly 40 years.[91] Thompson had offices in the College of Fisheries where, since 1925, he was Director of the International Fisheries Commission (now International Pacific Halibut Commission) charged with the management of, and research on, the Pacific halibut, *Hippoglossus stenolepis*, fishery.[92] He had just received his Ph.D. from Stanford University where he was trained by the two preeminent figures in fisheries of the era, Charles Henry Gilbert and David Starr Jordan. Thompson was appointed Research Professor and Director of the new department on a part-time basis, as he remained Director of the International Fisheries Commission. He remained Director of the school until 1947 when he resigned to establish and head the U.W.'s new Fisheries Research Institute (Stickney, 1989; Dunn, 2002).

Thompson instituted an entirely new approach to fisheries education at the U.W., concentrating on the emerging field of fisheries science. He revised the curriculum to emphasize basic science (Table 5) and not the technology of the

[89] Notice from David Thomson, Dean of Faculties, dated U.W., 4 Apr. 1930. "On Saturday, March 29, 1930, the University's Board of Regents voted to consolidate the present College of Fisheries with the College of Science." University of Washington Archives, Accession No. 71-34, Box 122, Folder 6. Stickney (1989) provided background information on the dissolution of the College of Fisheries. Schultz was soon re-assigned to the new Department of Fisheries.

[90] Governor Roland H. Hartley to President M. Lyle Spencer, dated Olympia, 7 Apr. 1930 "Am handing to you herewith a telegram from 'Fisheries Students, University of Wash., received this morning, which will explain itself. I will thank you for any information you may see fit to give me regarding the situation. Please return the telegram." David Thompson, Dean of Students, to Governor Hartley, dated U.W., 8 Apr. 1903. "For many years the University, as you may be aware, has held the apparent distinction of possessing the only College of Fisheries in the United States. Under the direction of the late John N. Cobb, dean of the college from its inception until his recent death, the fisheries work became widely known, giving the University publicity in many countries of the world.

Of late years it was felt, however, that the fisheries work was not organized in such a way as to permit instruction of a sound scientific nature; that too much of the students' time was devoted to the study of technology work which too closely paralleled work in the fishing industry.." University of Washington Archives, Presidents Office Records, Accession No. 71-34, Box 122, Folder 5. The College of Science is first listed in the U.W. Catalog for 1930–1931, p. 105–120. A Department of Fisheries in the College of Science is first found in the Bulletin of the U.W. Catalog for 1931–1932 Sessions, General Series No. 300, p. 286–287. The Department of Fisheries was elevated to a School of Fisheries in the U.W. Catalog for 1934–1935, General Series No. 380, p. 192–193. University of Washington Archives.

[91] Thompson to M. Lyle Spencer, President, dated International Fisheries Commission, 7 Aug. 1930; Spencer to Thompson, dated U.W., 8 Aug. 1930; Thompson to Spencer, dated International Fisheries Commission, 8 Sept. 1930 (with attached draft employment agreement); and Spencer to Thompson, dated U.W., 9 Sept. 1930. University of Washington Archives, President's files, Research Unit 71-34, Box 122, Folder 6.

[92] The International Fisheries Commission was established in 1923 by treaty between the United States and Canada and charged with conducting research on the halibut and regulating the fishery on this species. This treaty was the first international attempt to conserve and replenish a marine fishery. The Commission was renamed the International Pacific Halibut Commission in 1953. For more on the Commission, see Bell (1981).

Figure 13.—Dean Cobb [*ca.* 1920's]. University of Washington Archives, U.W. 9944.

commercial fishing industry.[93] To the present the School of Fisheries has continued the emphasis on fishery science and on graduate study (Stickney, 1989).

Summary

John Nathan Cobb (Fig. 13), with little formal education but with great ambition and self-education, rose from being a printer's aide to become in 1919 a Professor and founding Director of the College of Fisheries, University of Washington, Seattle. He was one of the last who could attain such a position without the benefit of at least one college degree. Cobb's story is one of the "American ideal," based on hard work and unrelenting pretension that led him to become a recognized expert in fisheries.

Cobb was highly regarded by his peers in the commercial fishing industry and by some of the leading scientists of the day. He began his career in fisheries with the U.S. Fish Commission in 1895 where he learned much about commercial fisheries in various regions of the country, the Northeast, Great Lakes, South Atlantic, and Gulf of Mexico, Alaska, and Hawaii, that served him well. His training in fisheries statistics made him particularly adept at compiling data. His publications about fisheries often provided the first written information about the subject. In particular his publications on fisheries for Pacific salmon (Cobb, 1911) and Pacific cod (Cobb, 1916b) provided the basic documentation for these west coast enterprises and for many years were held in high esteem by people in the fishing industry.

As an ambitious, self described "economic-man," Cobb left the Federal

[93] William F. Thompson (see footnote 57) was critical of Cobb in a draft "History of the School of Fisheries" written many years after Cobb's death: He felt that the concept upon which Cobb developed the School was at fault: "...It may also have been responsible for the failure of the College to develop distinctive lines of fundamental research, as he had no concept of the character and extent of work which such research required."

service mainly to improve his financial situation.[94] He entertained the possibility of returning to the Federal Service even as he was leading the College of Fisheries. There are several letters in the U.W Archives about Cobb's potential candidacy for Director of the Bureau of Fisheries. In a telegram from William Timson to Cobb, dated San Francisco, 21 February 1922, Timson sought confirmation that Cobb was available for appointment as Commissioner of Fisheries. Cobb wrote Miller Freeman, "Have wired Timson will accept Commissionership if tendered me."[95] Timson then wrote to Cobb "the APA and I, personally, had hoped that you would be the next Bureau [Fisheries] Chief, but that you had stated positively that you did not want it..." Thus, Cobb's willingness to become head of the U.S. Bureau of Fisheries did not come to frutation and, indeed, it appears Cobb was never offered the position.

Cobb deserves credit for his establishment and leadership of the U.W. College of Fisheries, the nation's first. His worldview of fisheries led him to establish a College devoted principally to the technology of the commercial fishing industry.[96] Cobb's original ideas about the format of the College were accepted by the U.W. administration, likely because they largely coincided with the ideas put forward earlier by Professor Trevor Kincaid and endorsed by Commissioner Hugh M. Smith of the U.S. Bureau of Fisheries.[38] He was a vigorous advocate for the development of the College. Cobb became aware that the College needed to improve its reputation among the faculty and administration of the U.W., but his time ran out before he could fully develop a scientific program.

Cobb's area of technical weakness became apparent when he tried to design fishways to pass salmon over high dams. His lack of scientific training, his inadequate knowledge of salmon biology, and his failure to seek both engineering and biological help in his fish passage research are partial reasons for the failure of his ill-conceived studies. Cobb's strong personality endeared him to the commercial fishing industry, but likely caused friction with the scientifically trained faculty of the College. He brought publicity to the College that was welcome to the U.W.

Upon Cobb's passing, the U.W. was fortunate to have on campus William F. Thompson, whose scientific stature was increasing. Thompson's worldview of fisheries was based on science, rather than the commercial fishing industry. His views have stood the test of time as they are largely in effect today at the School of Aquatic and Fishery Sciences at the U.W.

Acknowledgments

I thank T. W. Pietsch, School of Aquatic and Fishery Sciences (SAFS), U.W., for helpful discussions in the preparation of this manuscript, for his generosity in providing help, and in critically reviewing a draft of this paper. Marcus Duke, SAFS, kindly made the SAFS archives available for my use. Fred Utter (SAFS) brought to my attention the manuscripts by Joanne Webb and Dave Henken. The U.W. Manuscripts, Special Collections, and University Archives allowed me to use the John N. Cobb papers and photographs, and offered me other help.

William Cox, Smithsonian Institution Archives, Washington, D. C., kindly provided copies of the Cobb papers in his archives. Kirsten van der Veen of the Dibner Library of the History of Science & Technology, Smithsonian Institution, Washington, D.C., also provided copies of Cobb letters.

I thank Willis Hobart, National Marine Fisheries Service, Seattle, for providing me with historical information about fisheries. His extensive knowledge of fisheries history is a valuable resource that is freely shared with others.

Through the power of the Internet, Honor Conklin, a great granddaughter of John Cobb's brother, Samuel George Cobb (1864–1934), became aware of this project and contacted me. She kindly furnished me with information about the Cobb family, provided photographs of John Cobb, and demonstrated keen interest in the history of the Cobb family. I am indebted to her for assistance in this project.

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[94] Cobb had catholic interests. In addition to his interest in fisheries, fisheries history, and photography, he was a prolific writer who submitted many articles on natural history and other subjects to magazines and newspapers. The U.W. Archives contain a notebook listing the non-fisheries articles he submitted for publication. The notebook indicates whether or not the article was accepted and, if so, how much he was paid. He also visited cemeteries in various cities to view the headstones of famous people interred there, and kept records of his visits. U.W. Archives, Accession No. 1595-6, Box 9, Folder 6 and Box 10, Folder 5.

[95] University of Washington Libraries, Accession No. 1595-6, Box 1, Folder 7. Freeman to Cobb, dated Seattle, 21 Feb. 1922. Cobb to Freeman, dated Seattle, 23 Feb. 1922, University of Washington Libraries, Accession No. 1595-6, Box 1, Folder 30. Timson to Cobb, dated San Francisco, 23 Feb. 1922: University of Washington Archives, Accession No. 1595-6, Box 1, Folder 6.

[96] Twenty years after Cobb's death, the U.S. Fish & Wildlife Service (the successor agency to the U.S. Bureau of Fisheries) recognized Cobb's contributions to fisheries by naming a research vessel after him. The RV *John N. Cobb* was commissioned on 18 Feb. 1950 and, based in Seattle, continues as a research platform some 54 years later. For more on the RV *John N. Cobb*, see http://www.afsc.noaa.gov/Quarterly/ond99/html/items.htm.

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A Test of Computer-assisted Matching Using the North Pacific Humpback Whale, *Megaptera novaeangliae*, Tail Flukes Photograph Collection

SALLY A. MIZROCH and SUZANNE A. D. HARKNESS

Introduction

In the mid 1960's, researchers began to photograph individual marine mammals with the express purpose of using the images to identify individual animals on the basis of natural markings. Over time, researchers began to develop photo catalogs of individuals as they were sighted and photographed in different years and areas (Hammond et al., 1990). As the number of photographs has increased, so did the need for computer assistance to help with the collation and integration of the large collections.

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ABSTRACT—Testing was conducted of a computer-assisted system for matching humpback whale tail flukes photographs. Trials with a 12,000-photographs database found no differences in match success between matching by computer and matching by comparing smaller catalogs ranging in size from 200 to 400 photographs. Tests with a 24,000-photographs database showed that, on average, the first match was found after examining about 130 photographs whether the photograph quality was excellent, good, or poor. Match success did not appear to be strongly related to whether the tail flukes had especially distinctive markings or pigment patterns (recognition quality). An advantage of computer-assisted matching is the ability to compare new photographs to the entire North Pacific collection, where no bias is introduced based on expectation of resightings within or between specific areas, or based on expectation of behavioral role (e.g. matching "known" females to "known" females).

Starting in the mid 1980's, computer-assisted systems began to be developed to aid in the identification of individual marine mammals (Hiby and Lovell, 1990; Mizroch et al., 1990). The system developed by Hiby and Lovell use a scanned image and a 3-dimensional computer model to interpret the photograph and to develop an identification algorithm. Their system is considered semi-automated because the computer system measures some of the photograph's characteristics independent of the system operator. The system developed by Mizroch and colleagues is categorical and requires that identification photographs be classified visually by a trained observer. This system is based on a categorization scheme of natural marks and scars, and data related to each photograph are entered into a computer database. The system operator controls all of the matching information and uses a computer to query the database for possible matching choices.

The NMFS National Marine Mammal Laboratory (NMML) has been developing and curating a collection of humpback whale, *Megaptera novaeangliae*, tail flukes photographs taken in North Pacific waters since 1985. This collection has grown from about 750 images in 1986 to about 24,000 in 1999, representing contributions from over 18 research groups from all regions in the North Pacific (Table 1). Unique NMML identification numbers (NMMLID) are assigned only when there are at least 2 photographs of a particular individual whale in the database. As of April 1999, 3,093 unique NMMLID numbers had been assigned and 12,057 tail flukes photographs had been assigned a NMMLID; 11,156 tail flukes photographs had not yet been assigned a NMMLID. Overall, the 23,213 tail flukes photographs evaluated

Table 1.—Major contributing research groups and primary contact people.

Research group/affiliation	Primary contact
Center for Coastal Studies	D. Mattila
Cascadia Research Collective	J. Calambokidis, G. Steiger
Center for Whale Research	K. Balcomb, D. Claridge
Center for Whale Studies	D. Glockner-Ferrari, M. Ferrari
Glacier Bay National Park and Preserve U.S. Dep. Interior, Gustavus	C. Gabriele
Hawaii Whale Research Foundation	D. Salden
J. Straley Investigations	J. Straley
Kewalo Basin Marine Mammal Laboratory University of Hawai'i	L. Herman, A. Craig
Moss Landing Marine Labs California State Universities	S. Cerchio
North Gulf Oceanic Society	O. von Ziegesar, C. Matkin
National Marine Mammal Laboratory NMFS, NOAA, Seattle	S. Mizroch
Okinawa Expo Aquarium	S. Uchida, N. Higashi
Pacific Biological Station Dep. Fish. Oceans, Nanaimo	G. Ellis
SeaSearch	C. and S. Jurasz
Univ. Autonoma de Baja Calif. Sur	J. Urban
Univ. Nacional Autonoma de Mexico	M. Salinas, J. Jacobsen
West Coast Whale Research Foundation	J. Darling, E. Mathews, D. McSweeney, K. Mori

in this paper may represent the sightings and resightings of no more than 6,000 individual humpback whales.

When conducting certain numerical studies using photo-identification data (e.g. capture-recapture analyses), it is important to segregate the photographic data strictly on photographic quality only (Hammond, 1986; Hammond et al., 1990; Mizroch et al., 1990). Photographs in the NMML database are given two different ratings: one based on photographic quality (focus, angle, distance), and the other based on recognition quality (distinctive pattern, marks, or scars) (Mizroch et al., 1990, provide more details). The analysis conducted in this paper stratified the photographs by three levels of photographic quality (hereafter simply referred to as photo quality), examples of which are shown in Figure 1. Matching was conducted using the system described in Mizroch et al. (1990), except that the patterns in use today (Fig. 2) have been simplified and improved. The tail flukes map (Fig. 3) has not been modified.

Tests of the NMML system (i.e. stratified by recognition quality) were first presented in Mizroch et al. (1990), when the database contained 9,353 photographs. Here, we present test results for the NMML database when it contained 12,000 photographs (using ad hoc tests conducted from 1991 to 1995), and tests with the database at its current size of nearly 24,000 photographs.

Table 2.—Number of photographs in the database stratified by photo quality (focus, etc.) (Fig. 1) and recognition quality (distinctiveness).

	Recognition quality						
Photo quality	1	2	3	0[1]	Total photos	1% of database	0.5% of database
1, excellent	2,742	420	40		3,202	30	15
2, good	7,255	6,627	1,642		1,5,524	160	80
3, poor	1,032	2,152	2,434	84	5,702	60	30
Total	11,029	9,199	4,116	84	24,428	250	125

[1] Category 0 means that the recognition quality cannot be evaluated due to poor photo quality

Methods

Categorizing Whale Tail Flukes

Humpback whale tail flukes have black and white pigment patterns that can match one or several categories (Fig. 2). For each photograph, a selection of patterns that most closely resembled the tail flukes was chosen. In general, the user selected between one and six patterns for each photo being matched, depending on what characteristics were visible on the photograph to be matched. In addition to selecting patterns, the user evaluated locations of natural markings, scars, or other unique marks on the tail flukes (Fig. 3), and selected any or all sectors that contained the markings (e.g. a distinctive line in Sector 5 and an open circle in Sector 6). If the mark extended across sectors, it was described in both. If it was not clear which sector to select, a mark was described as being in one or the other.

For each photograph matched, after the input criteria were selected, the matching program queried the database and brought up a subset of all photographs in the database that matched the input criteria and displayed each photograph sequentially on a television monitor, with related data for each photograph on a computer monitor. The operator compared each photograph on the television monitor to the photograph to be matched and determined if there was a match or not. In cases where the photograph on the television monitor was difficult to interpret, the operator pulled the original photograph from the files for further evaluation.

Testing with 12,000 Photographs

As part of data preparation for analyses of calf mortality and birth interval, humpback whale researchers in the North Pacific conducted an ad hoc matching test in the early 1990's. Researchers from Glacier Bay National Park and Preserve[1] (Gabriele), University of Alaska[2] (Straley), and North Gulf Oceanic Society (currently known as Eye of the Whale[3]) (von Ziegesar), working independently of each other and NMML staff (primarily A. Wolman), compared their catalogs to a catalog of known females prepared during a workshop on calf mortality (called here the "calf mortality" catalog, containing 352 individual whales, unpubl. data on file at the NMML). Their catalogs, which represented Alaska areas including Glacier Bay, portions of southeastern Alaska, and Prince William Sound, ranged in size from about 200 individuals to about 400 individuals. The tail flukes photograph collection at the NMML at the time of the matching exercise numbered about 12,000 photographs including photographs from all regions in the North Pacific. The matching success of computer-assisted matching at the NMML was compared with the matching success of each individual researcher visually inspecting their own hard-copy catalogs (Mizroch[4]).

[1] Humpback Whale Monitoring Program, Glacier Bay National Park and Preserve, P.O. Box 140, Gustavus, AK 99826.

[2] University of Alaska Southeast Sitka Campus, 1332 Seward Avenue, Sitka, AK 99835.

[3] Eye of the Whale, P.O. Box 15191, Fritz Creek, AK 99603.

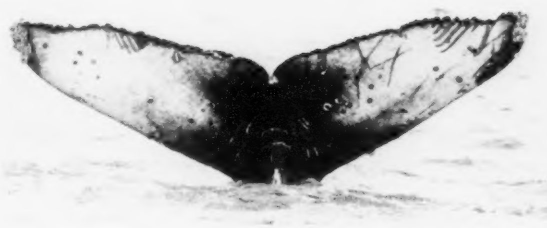
Testing with 24,000 Photographs

A random selection of about 0.5% of the database (116 photographs) was made, stratified by photo quality codes (Table 2). Based on the stratification, there were 15 photo quality 1 (excellent) photos, 75 photo quality 2 (good or moderate) photos, and 26 photo quality 3 (poor) photos selected. The draw from the database was independent of recognition quality and of whether the animal had been matched previously.

At the time of the matching exercise, we did not know whether the photographs had been matched previously. For each photograph selected, the computer-assisted matching program was used to match each photograph to the entire collection, and matching was halted either when the first match was found, or when about 5% of the database (1,250) photographs had been examined. If the photograph was of a well-known animal, the match criteria used for this exercise were based strictly on the detail showing on the photograph

[4] Mizroch, S. A. Report of the workshops on the estimation of calf mortality in North Pacific humpback whales. 38 p., Unpubl. data.

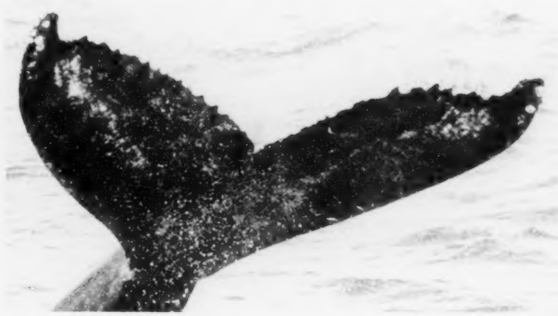
45598



23407

Excellent: Photo Quality 1

50236



10465

Good: Photo Quality 2

60328

23141

Poor: Photo Quality 3

Figure 1.—Photographs that illustrate the photo quality codes.

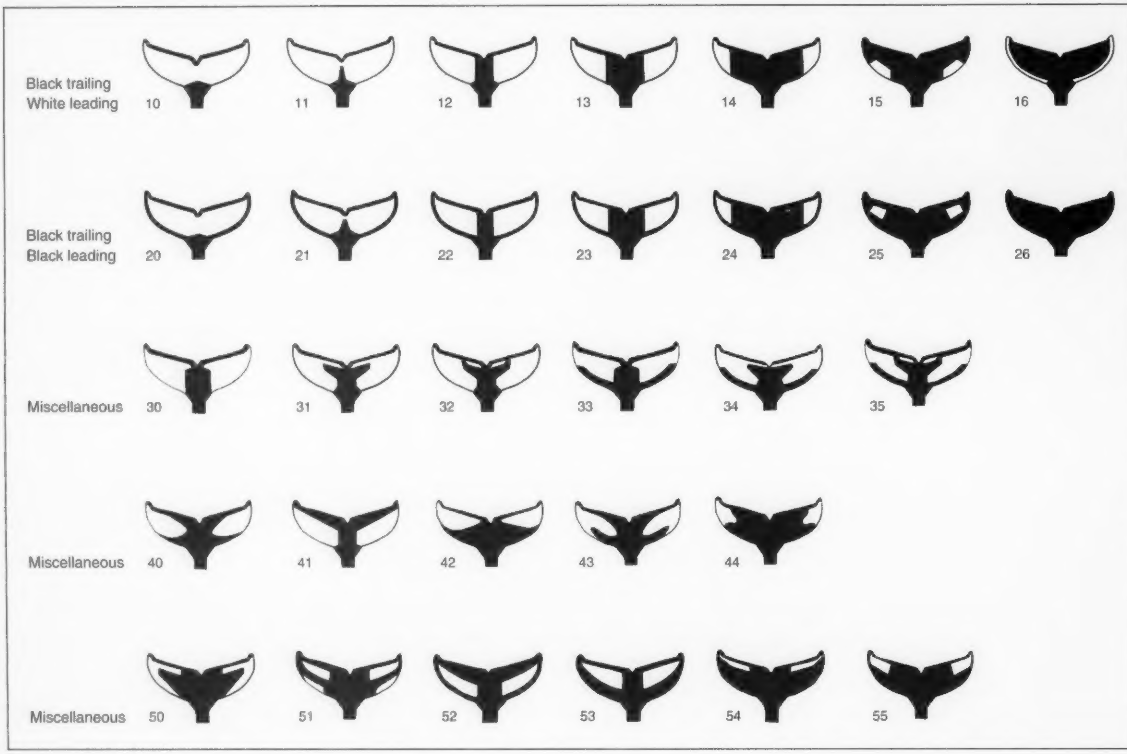


Figure 2.—Tail flukes patterns (numbers shown at lower left of each pattern are the pattern codes used in the database), slightly modified and updated from the patterns presented in Mizroch et al. (1990).

drawn randomly, rather than on other known marks or scars that the individual may have accumulated over time.

Results

Testing with 12,000 Photographs

The Glacier Bay catalog (unpubl. data) numbered about 200 individual whales at the time of the matching exercise. Ten of the 12 matches between the "calf mortality" catalog and the Glacier Bay catalog were found independently by both Gabriele and Straley and by NMML staff. Gabriele and Straley found one match that NMML staff missed and NMML staff found one match that Gabriele and Straley missed (Table 3).

The southeastern Alaska catalog numbered about 400 individual whales at the time of the matching exercise. Both Straley and NMML staff found 19 of the 21 matches between the "calf mortality" catalog and the southeastern Alaska catalog independently. Straley found one match that was missed by NMML staff, and NMML staff found one match that was missed by Straley (Table 3).

Table 3.—Comparisons of computer-assisted matches and matches from each Alaska research group, matching the "calf mortality" catalog to each independent collection. The "calf mortality" catalog included photographs of about 350 individual whales, and the NMML database contained about 12,000 tail fluke photographs at the time of this matching exercise.

Catalog	Approx. sample size	Observed by both NMML and research group	Total no. of matches found
Glacier Bay (Gabriele)	200	10	12
Southeastern Alaska (Straley)	400	19	21
Prince William Sound (von Ziegesar)	200	6	10

The Prince William Sound catalog numbered about 200 individual whales at the time of the matching exercise. Both von Ziegesar and NMML staff found 6 of the 10 matches found between the "calf mortality" catalog and the Prince William Sound catalog independently. Von Ziegesar found three matches that NMML staff missed and NMML staff found one that von Ziegesar missed. The number of matches missed from this set was somewhat larger than the others (Table 3). For at least one of the matches made by von Ziegesar and missed by NMML staff, the photo quality was poor, and the match was based mainly on trailing edge shape and detail, and not the marks, scars, and pigment patterns that

were apparent on a good quality photograph of the tail.

Overall, 38 of the 43 total matches found (88%) were made using the computer-assisted system. There was no significant difference in matches found for each area (Chi-square = 4.37, P = 0.11).

Testing with 25,000 Photographs

Photo Quality 1

Of the 15 images in this category, matches were found for all 15 photographs. In 10 cases, the first match was found in the top 0.0027 of the database (fewer than 70 photographs evaluated). In all 15 cases, the first match was found in the top 0.031 of the database (Table 4, Fig. 4). On average, the first match was found in the top 0.0052 of the database (about 130 photographs) (SD = 0.0079).

Examples of two of the photo quality 1 matches, including the pattern and marks selections are presented in Figures 5 and 6. Figure 5 shows a match that was found after making one change in selection criteria and evaluating 69 photographs. Figure 6 shows a whale that had no apparent marks, and the match was found after evaluating 793 photographs.

Photo Quality 2

Of these 75 images, matches were found for 45 photographs. Of these 45, in 27 cases the first match was found in the top 0.0027 of the database (70 or fewer photographs evaluated) (Table 5, Fig. 4). On average, the first match was found in the top 0.0056 of the database (about 130 photographs) (SD = 0.0072).

In only three cases, known matches of photo quality 2 photos were missed, due to the following reasons (Fig. 7):

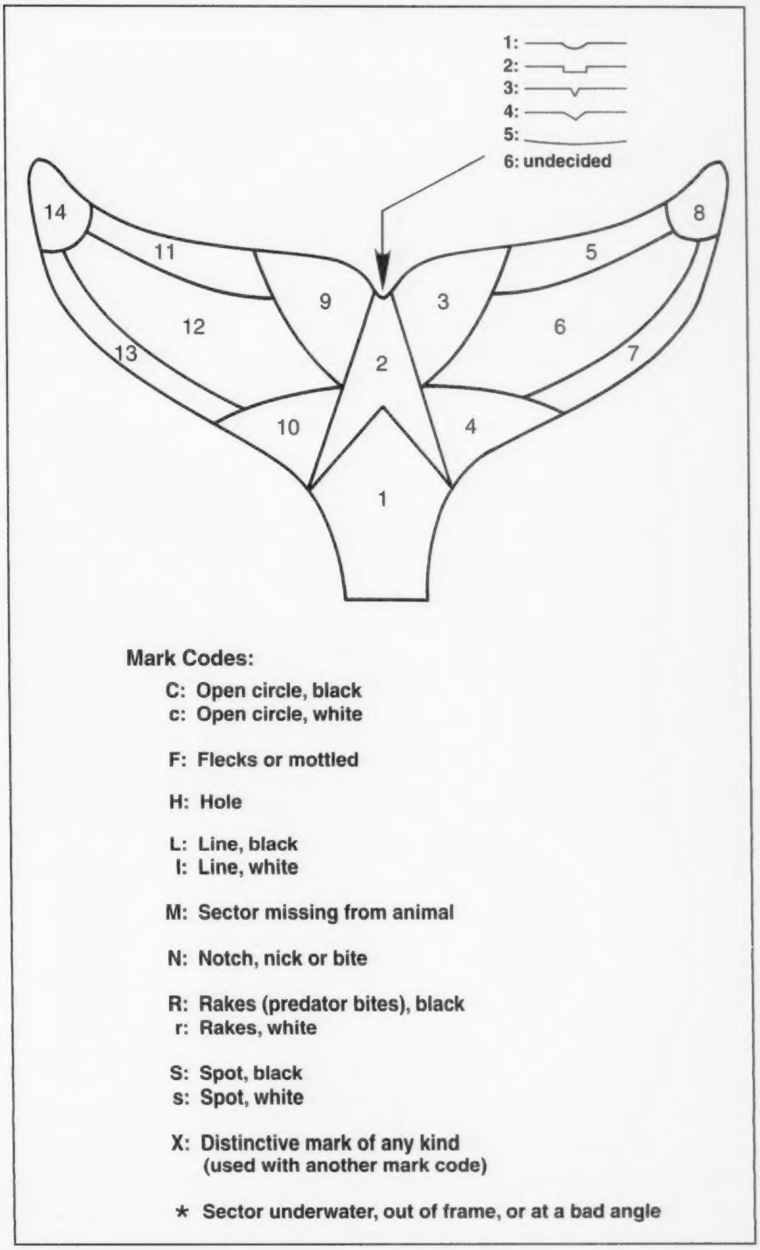


Figure 3.—Tail flukes map.

1) For photograph 5889, the flecked markings (speckled or streaked pigment markings which were present in both Sectors 5 and 8) did not appear to be present in Sector 5 on the photograph missed in the database, so the matching photograph was not selected in any of the matching selections.
2) For photograph 50363, the matching photograph lacked any detail, and would have been found only after looking at more than 1,250 photographs, the arbitrary cut-off point for this exercise, because of where it was on the list of photos selected from the database.
3) For photograph 61147, the distinctive circle in Sector 6 was present but not coded as such on the photograph in the database, so the matching photograph was not selected in any of the matching selections.

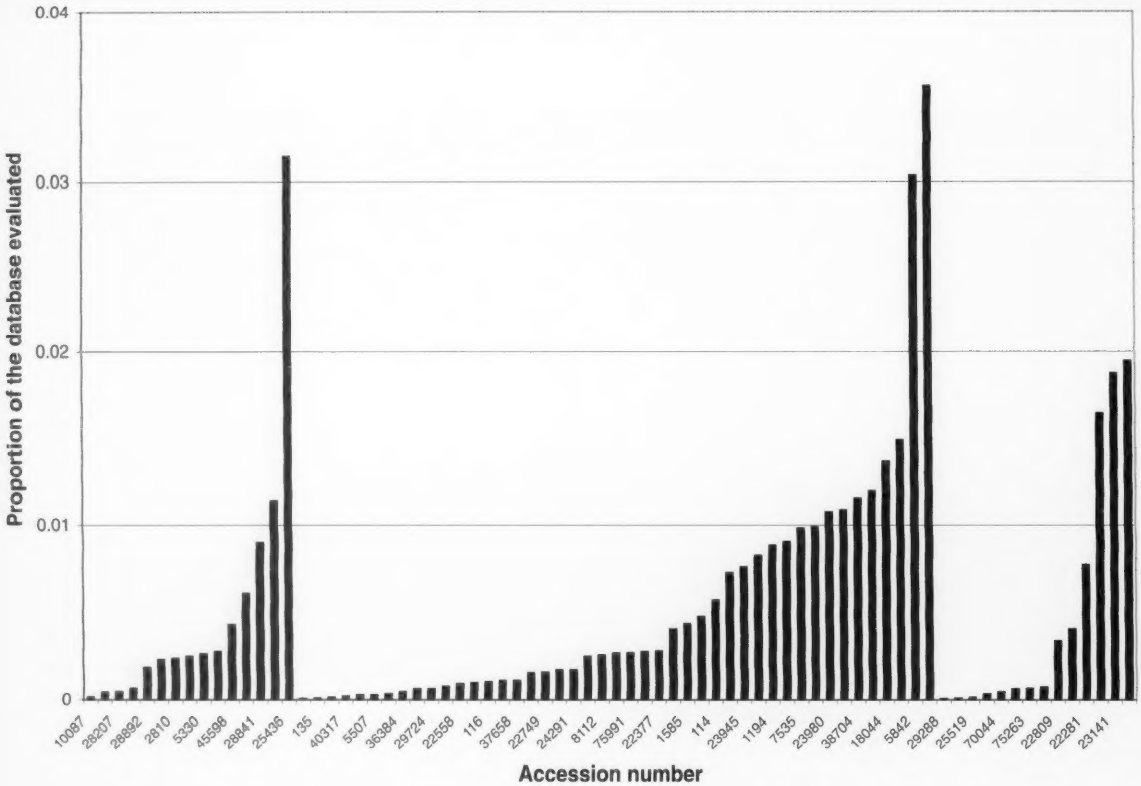


Figure 4.—Test results for photographs where matches were found, photo qualities 1–3.

Examples of two of the photo quality 2 matches, including the pattern and mark selections, are presented in Figure 8. Figure 8 shows a match that was found after making two changes in selection criteria and evaluating 764 photographs.

Photo Quality 3

Of these 26 images, matches were found for 14 photographs. Of these 14 photographs, in 9 cases the first match was found in the top 0.0034 of the database (85 or fewer photographs evaluated) (Table 6, Fig. 4). On average, the first match was found in the top 0.0052 of the database (about 125 photographs) (SD = 0.0071).

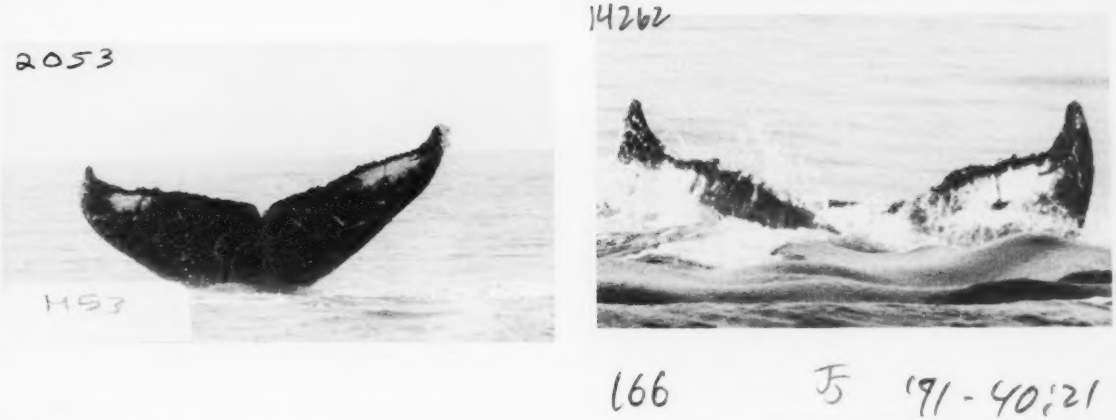
In only two cases, known matches of photo quality 3 photographs were missed due to the following reasons (Fig. 7):

1) For photograph 9774, only part of one tail fluke was showing, and there were very few distinguishing marks present.

2) For photograph 34697, the photo quality was so poor that the match could only be confirmed by the researcher who took the photo.

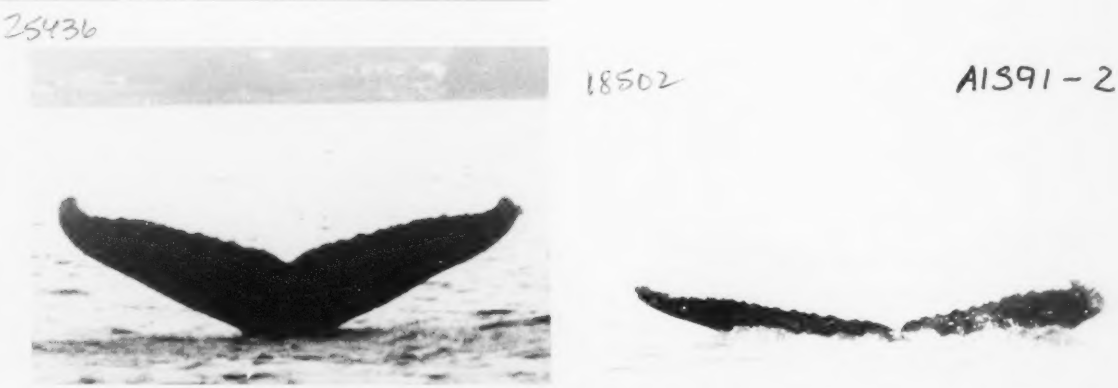
Table 4.—Photo quality 1 results, including numbers of photographs examined and origin of each photo.

Accession no.	Recognition quality	No. photographs examined until first match was found	Proportion of the database examined	Geographic origin of photo
10087	1	4	0.000158648	Hawaii
848	1	11	0.000436283	Hawaii
28207	1	12	0.000475945	Hawaii
23827	1	17	0.000674255	Hawaii
28892	1	45	0.001784794	Hawaii
29233	1	56	0.002221076	Hawaii
2810	1	58	0.002300401	Mexico
23407	1	61	0.002419387	Hawaii
5330	1	65	0.002578035	Alaska
2053	1	69	0.002736683	Mexico
45598	1	107	0.004243842	California
9115	1	153	0.006068298	California
28841	1	227	0.009003292	Hawaii
9768	2	288	0.011422679	California
25436	2	793	0.031452029	Alaska
Average (Standard Deviation)		131.0667	0.005198 (0.007949)	



Patterns used to find the match	Marks/Scars used	Number of photographs evaluated
54, 55	XL in 11	57
54, 55	L in 5 and 11	12
		69

Figure 5.—Example of the evaluation of photo accession number 2053, coded as photo quality 1.



Patterns used to find the match	Marks/Scars used	Number of photographs evaluated
26	none	793

Figure 6.—Example of the evaluation of photo accession number 25436, coded as photo quality 1.

An example of a photo quality 3 match, including the pattern and marks selections (Fig. 9) shows a match that was found after making two changes in selection criteria and evaluating 101 photographs.

Results for photos of qualities 1 though 3 were surprisingly similar. In Figure 10, results are presented independent of photo quality, sorted by match success, with recognition quality plotted for each photograph. Recognition quality is based on the presence of distinctive markings or pigmentation, which should affect one's ability to recognize the individual even if photo quality is very poor. There did not appear to be a trend in recognition quality with respect to known matches that were

missed. Also, there did not appear to be a trend with respect to the photographs as yet unmatched (Fig. 11).

Overall, matches were found for 74 of the 116 photographs, and on average, the first match was found in the top 0.0054 of the database (about 130 photographs) (SD = 0.0073).

Discussion

Testing with 12,000 Photographs

This exercise confirmed that computer-assisted matching was an effective tool, especially considering that NMML staff was comparing the "calf mortality" catalog to a collection of over 12,000 photographs and not to individual catalogs ranging in size from 200–400 photographs.

Testing with 25,000 Photographs

Figure 10 indicates no trend in match results with respect to recognition quality, which may mean that even the less distinctive tail flukes photographs have enough detail so matches can be found.

Of the 116 photographs selected at the time the matching exercise began, only 52 had been previously matched (i.e. assigned a NMMLID). New matches were found for 26 of the photographs and 38 remain without known matches. Overall, only five known matches were missed.

An advantage of computer-assisted matching is the ability to compare new photographs to the entire North Pacific collection and the potential to find matches to whales photographed in other regions. No bias is introduced based on expectation of resightings within or between specific summer or winter grounds. Another advantage in using computer-assisted matching is that by matching to the entire collection, no bias is introduced based on expectation of behavioral role (e.g. matching "known" females to "known" females).

At this time, the NMML computer matching system is able to match images effectively with a database of over 25,000 photographs to choose from. The computer-assisted system has continued to be an efficient matching system for such a large number of photographs because the matching criteria are always con-

Table 5.—Photo quality 2 results, including numbers of photographs examined and origin of each photo.

Accession number	Recognition quality	No. photographs examined until first match found	Proportion of database examined	Geographic origin of photo
29213	1	1	3.96621E-05	Hawaii
135	2	2	7.93242E-05	Alaska
37195	1	3	0.000118986	Alaska
40317	2	5	0.00019831	Hawaii
6832	1	7	0.000277635	Alaska
5507	2	7	0.000277635	Alaska
39389	1	9	0.000356959	Hawaii
36384	1	12	0.000475945	Alaska
28227	1	16	0.000634593	Hawaii
29724	2	16	0.000634593	Hawaii
39914	2	20	0.000793242	Hawaii
22558	1	24	0.00095189	Hawaii
23683	2	25	0.000991552	Hawaii
116	1	26	0.001031214	Alaska
39138	1	28	0.001110538	Hawaii
37658	3	28	0.001110538	Alaska
60184	2	38	0.001507159	Hawaii
22749	1	39	0.001546821	Hawaii
34584	1	42	0.001665807	Hawaii
24291	2	42	0.001665807	Hawaii
36179	2	61	0.002419387	Alaska
8112	1	63	0.002498711	Hawaii
16240	1	66	0.002617697	Mexico
75991	1	67	0.002657359	Alaska
38357	1	69	0.002736683	Alaska
22377	1	70	0.002776346	Hawaii
23914	2	101	0.00400587	Hawaii
1585	1	108	0.004283505	Hawaii
5502	3	118	0.004680125	Alaska
114	2	143	0.005671677	Alaska
28574	1	182	0.007218498	Hawaii
23945	3	191	0.007575457	Hawaii
39955	2	208	0.008249712	Hawaii
1194	1	223	0.008844644	Hawaii
50236	1	228	0.009042954	Hawaii
7535	1	247	0.009796534	Alaska
39102	1	249	0.009875858	Hawaii
23980	2	272	0.010788086	Hawaii
25855	2	275	0.010907072	Alaska
38704	2	292	0.011581327	Alaska
44091	2	302	0.011977948	Hawaii
18044	2	346	0.013723079	Alaska
9078	1	375	0.01487328	California
5842	1	764	0.030301828	Alaska
12102	2	897	0.035576885	Alaska
1547	2	No match	0.05	Hawaii
2003	2	No match	0.05	Mexico
2935	2	No match	0.05	Mexico
5380	2	No match	0.05	Alaska
5889	1	No match	0.05	California
10465	1	No match	0.05	Hawaii
10592	1	No match	0.05	Hawaii
10848	2	No match	0.05	Hawaii
10973	1	No match	0.05	Hawaii
11171	2	No match	0.05	Hawaii
14802	3	No match	0.05	Mexico
16300	1	No match	0.05	Mexico
16327	1	No match	0.05	Mexico
17430	1	No match	0.05	Alaska
23506	1	No match	0.05	Hawaii
27102	2	No match	0.05	Hawaii
30394	2	No match	0.05	Japan
37170	3	No match	0.05	Alaska
37410	2	No match	0.05	Alaska
39090	3	No match	0.05	Hawaii
40418	2	No match	0.05	Hawaii
44567	2	No match	0.05	Hawaii
45217	3	No match	0.05	California
45651	3	No match	0.05	Oregon
50363	2	No match	0.05	Hawaii
50400	2	No match	0.05	Hawaii
60328	3	No match	0.05	Hawaii
60620	2	No match	0.05	Hawaii
61147	2	No match	0.05	Hawaii
99914	2	No match	0.05	Colombia
Average (Standard Deviation)		133.4127	0.00556 (0.00729)	

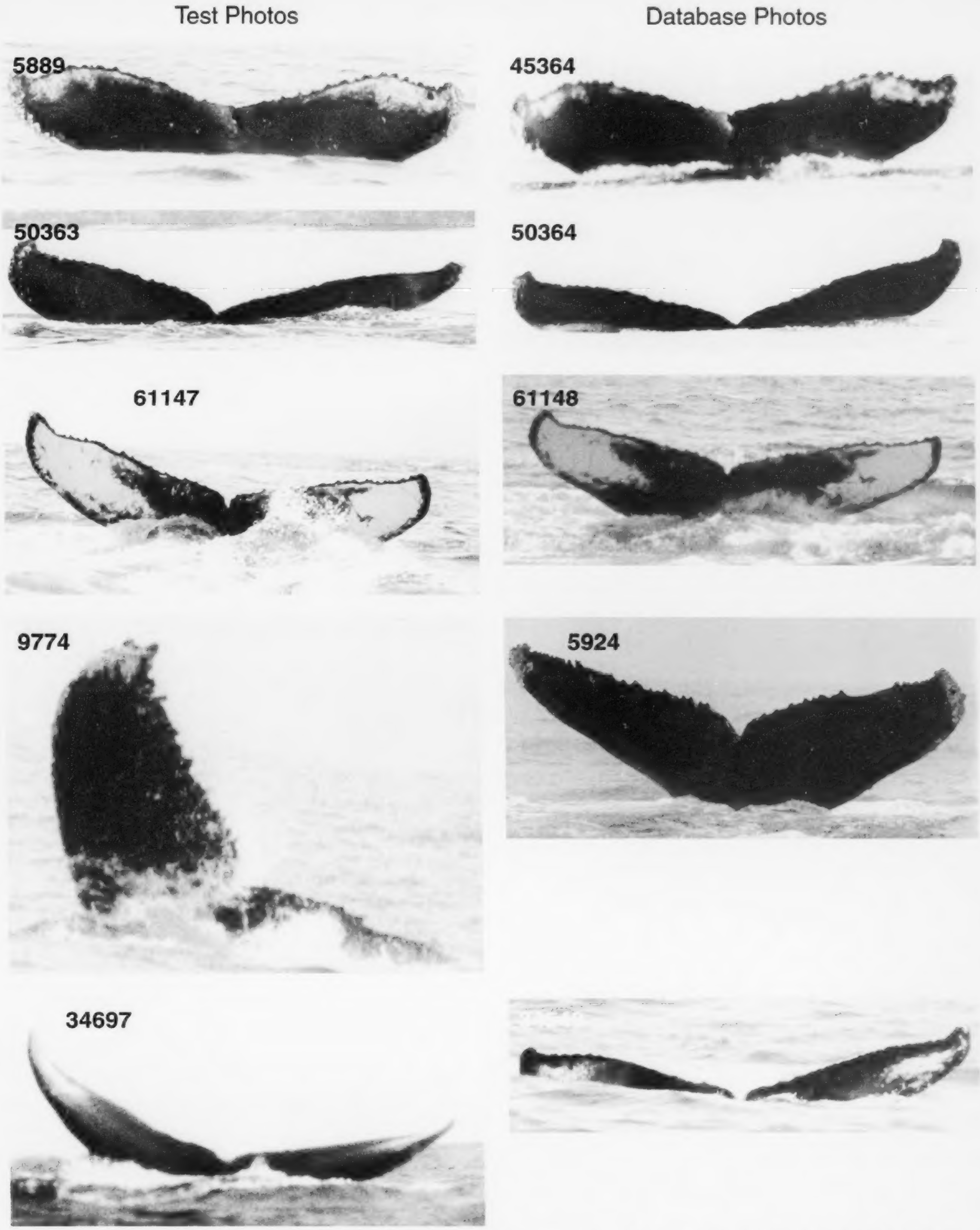
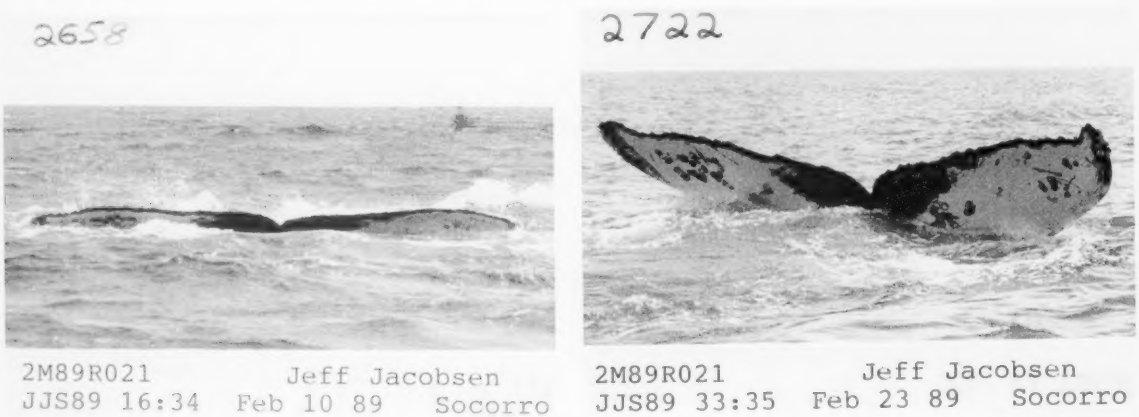


Figure 7.—Examples of photographs where matches were missed. These photographs were coded as photo quality 2 and 3. The test photos are on the left, and the missed matches are on the right.

Patterns used to find the match	Marks/Scars used	Number of photographs evaluated
13, 40, 41, 43	X in 11 or 13	170
13, 40, 41, 43	L in 5 and S in 13	344
13, 40, 41, 43	F in 6	250
		764

Figure 8.—Example of the evaluation of photo accession number 5842, coded as photo quality 2.



Patterns used to find the match	Marks/Scars used	Number of photographs evaluated
12, 13, 40	XS in 11	74
12, 13, 40	XC in 11	4
12, 13, 40	XC or XS in 12	23
		101

Figure 9.—Example of the evaluation of photo accession number 2658, coded as photo quality 3.

Table 6.—Photo quality 3 results, including numbers of photographs examined and origin of each photo.

Accession no.	Recognition quality	No. photographs examined until first match found	Proportion of database examined	Geographic origin of photo
29288	2	1	3.96621E-05	Hawaii
34937	3	2	7.93242E-05	Hawaii
25519	3	3	0.000118986	Alaska
80029	2	9	0.000356959	Mexico
70044	2	12	0.000475945	Mexico
174	2	16	0.000634593	Hawaii
75263	0	17	0.000674255	Alaska
5755	0	19	0.00075358	Mexico
22809	3	85	0.003371277	Hawaii
2658	1	101	0.00400587	Mexico
22281	1	194	0.007694443	Hawaii
9418	2	416	0.016499425	California
23141	2	473	0.018760163	Hawaii
37034	1	491	0.019474081	Alaska
1783	1	No match	0.05	Hawaii
9774	2	No match	0.05	California
10725	2	No match	0.05	Hawaii
22031	2	No match	0.05	Hawaii
23785	3	No match	0.05	Hawaii
28185	3	No match	0.05	Hawaii
29292	3	No match	0.05	Hawaii
34549	2	No match	0.05	Hawaii
34697	3	No match	0.05	Hawaii
37237	3	No match	0.05	Alaska
46410	3	No match	0.05	California
50102	2	No match	0.05	Hawaii
Average (Standard Deviation)		125.0375	0.005210 (0.007131)	

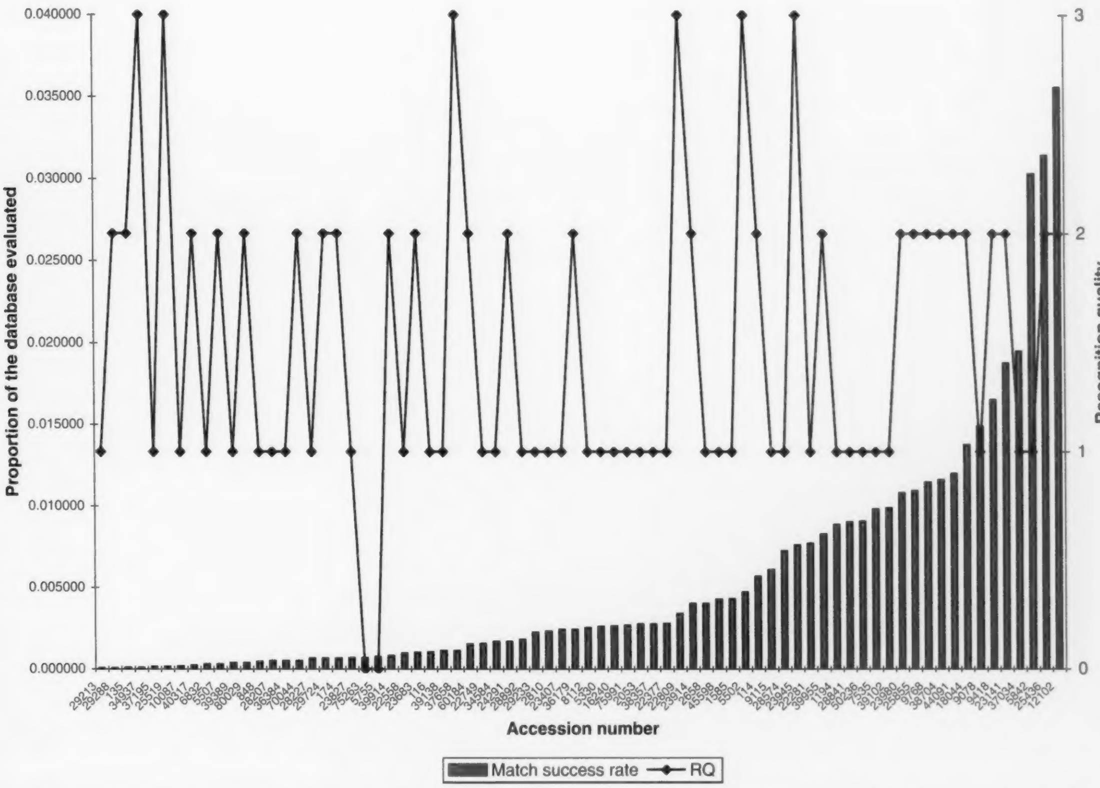


Figure 10.—Recognition quality (RQ) vs proportion of the database evaluated for each photograph. RQ 0: photo cannot be evaluated for recognition quality; RQ 1: Excellent; RQ2: Good or moderate; RQ3: Poor.

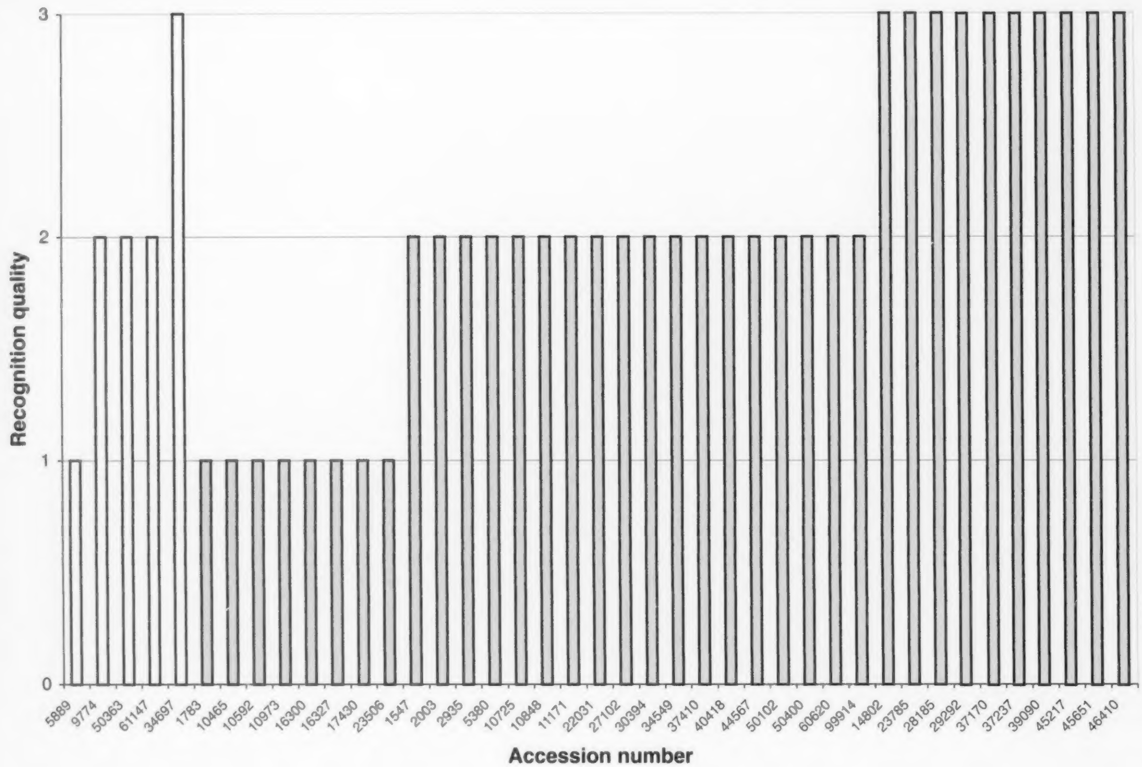


Figure 11.—Recognition quality of photographs where matches were not found. The first 5 bars (no color) represent photographs for which known matches were missed (see Fig. 7).

trolled by a human operator and because database performance is not constrained by size. Data entry is fast (between 100–200 photographs entered per day). Image capture and retrieval is fast, with the capability of capturing 5,000 images per day on a videodisc that holds 54,000 images. Image retrieval time ranges from a fraction of a second to perhaps 2 seconds, depending on the distance between images on the videodisc.

Conclusions

Since the NMML system has been in use, there has been a desire to develop computer-assisted systems that are more "automated." The NMML system takes advantage of the human brain's ability to instantly rotate, adjust, compensate, and recognize similar images. Computer technology cannot yet compete with the image processing power of the human brain, and it is not so advanced that a completely automated system is possible. Both the categorical systems used here and the other systems developed by Hiby take some operator training and intervention.

New systems are being developed for identifying individual Alaska harbor seals which should provide a direct comparison of categorical versus semi-automated systems. Future sample sizes will likely be large enough to compare the two approaches with rigor.

Acknowledgments

Thanks are due to Allen Wolman, who did most of the matching for the ad hoc study, to Sitha Hoy and Melissa Dolan, who did most of the data entry of the photographs in the database and provided many of the matches known to-date, and to Dave Rugh and Janice Waite for their help with photo quality coding. The paper was improved due to thoughtful reviews by NMML researchers Merrill Gosho, Sue Moore, and Janice Waite.

In addition, we thank the many research groups whose photographs are part of the research collection (see Table 1), including those groups who allowed us to use their photos as examples in this paper (photo credits in parentheses), including Cascadia Research Collective (Fig. 1: photo 45598; Fig. 7: photos 5889, 5924, 9774, and 45364), Center for Whale Research (Fig. 7: photos 5889 and 5924), Center for Whale Studies (Fig. 1: photos 23141 and 23407; Fig. 7: photos 50363 and 50364), Glacier Bay National Park and Preserve (Fig. 6: photo 18502), Hawaii Whale Research Foundation

(Fig. 1: photos 50236 and 60328; Fig. 7: 61147 and 61148), J. Straley Investigations (Fig. 8: photo 5842), J. Jacobsen and Universidad Nacional Autónoma de México (Fig. 5: photo 14262; Fig. 9: photos 2658 and 2722), Sal Cerchio and Moss Landing Marine Labs (Fig. 7: photo 34540 and 34697), National Marine Mammal Laboratory (Fig. 6: photo 25436), NMFS, Alaska Region (Fig. 8: photo 25013), Jorge Urbán currently of Universidad Autónoma de Baja California Sur (Fig. 5: photo 2053), West Coast Whale Research Foundation (Fig. 1: photo 10465).

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Juvenile Red Rockfish, *Sebastes* sp., Associations with Sponges in the Gulf of Alaska

J. LINCOLN FREESE and BRUCE L. WING

Introduction

Sponge–fish associations have been documented for a variety of species in both cold-water and tropical habitats. Eastman and Eakin (1999) found that fishes of the genus *Artedidraco* (Artedidraconidae) are associated with sponge beds in the Ross Sea of Antarctica. Likewise, Tokranov (1998) described the association of sponge sculpin, *Thyriscus anoplus* (Cottidae), with sponge beds in the northern Kuril Islands.

Konecki and Targett (1989) found that cod icefish, *Lepidonotothen larseni* (Nototheniidae), in waters adjacent to the Antarctic Peninsula utilize the spongocoel of the hexactinellid (glass) sponge *Rossella nuda* as a substrate on which to deposit their eggs. Notothenioid fishes known to utilize sponges as spawning and nesting sites include emerald rockcod, *Notothenia bernacchii* (Moreno, 1980) and Antarctic spiny plunderfish, *Harpagifer antarcticus* (Daniels, 1978). Antarctic fishes that utilize sponges for predator avoidance include sharp-spined notothen, *Trematomus pennellii*, and spotted notothen, *T. nicolai*, as well as the crocodile icefish, *Pagetopsis macropterus*. Dayton et al. (1974) state that glass sponges provide almost all of the vertical structure on the sea floor in the Ross Sea of Antarctica.

Finally, Munehara (1991) established that the silverspotted sculpin, *Blepsias cirrhosus* (Cottidae), uses the sponge *Mycale adhaerens* as a spawning bed, stating that the eggs benefit from this association through predator avoidance, oxygen supply, and the natural antibacterial and antifungal properties of the sponge. Konecki and Targett (1989) note that glass sponges serve as important nesting and refuge sites for Antarctic fishes, and destruction of sponge communities by bottom trawling could have an impact on fish ecology in the region.

The 1996 amendments to the Magnuson-Stevens Fishery Conservation and Management Act require that increased emphasis be placed on "essential" fish habitat (USDOC, 1996). One type of marine habitat that fishery managers must consider during decision-making is living substrate. In Alaska waters, living substrate is often provided by a variety of epibenthic fauna, such as deepwater corals (e.g. *Primnoa* spp., *Paragoria* spp.), sea whips (Pennatulacea), and a number of large, erect sponges (Heifetz, 2002; Malecha et al., In press). These taxa form a high-relief, complex habitat that is generally thought to foster increased biological diversity and productivity by providing abundant cover and food aggregations for fish in various stages of their life history (Collie et al., 1997).

Studies conducted in the Gulf of Alaska (GOA) have shown that the aforementioned organisms are heavily impacted by even one pass of a commercial bottom trawl (Freese et al., 1999; Krieger, 2001). These findings generally agree with those of studies conducted in other parts of the world (Watling and Norse, 1998; Auster and Langton, 1999; Moran and Stephenson, 2000). Trawl impacts can result from direct removal or damage to the megabenthos as well as changes in species composition over time (Wassenberg et al., 2002). Research in the GOA and elsewhere has shown that sponge communities and gorgonian coral colonies in boreal waters may be very slow to recover from trawl damage (Freese, 2003; Krieger, 2001).

An association between large *Primnoa* spp. colonies and six species of adult rockfish has been documented by Krieger and Wing (2002) in the GOA. Although it has been assumed that sponges at northern latitudes provide important habitat for fish in early stages of their life cycle in the GOA, there has heretofore been only anecdotal information available to support this assumption. This paper describes in situ observations made from a research submersible of an association between juvenile red rockfish, *Sebastes* spp., and one species of sponge in the GOA.

Materials and Methods

In June 2001, researchers from the NMFS Alaska Fisheries Science Center's Auke Bay Laboratory conducted a series of biological surveys in the eastern GOA, using the research submersible *Delta*. The *Delta* is a 4.7 m long, battery-powered underwater vehicle able to dive to

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ABSTRACT—In 2001, a research submersible was used to survey seafloor habitat and associated benthos in the northeastern Gulf of Alaska. One inspected site had a uniform sand-silt substrate, punctuated by widely spaced (10–20 m apart) boulders. Two-thirds of the boulders had sponge, Aphrocallistes *sp., colonies. Eighty-two juvenile (5–10 cm) red rockfish (*Sebastes *sp.) were also observed during the dive, and all of these fish were closely associated with the sponges. No juvenile red rockfish were seen in proximity to boulders without sponges, nor were any observed on the sand-silt substrate between boulders.*

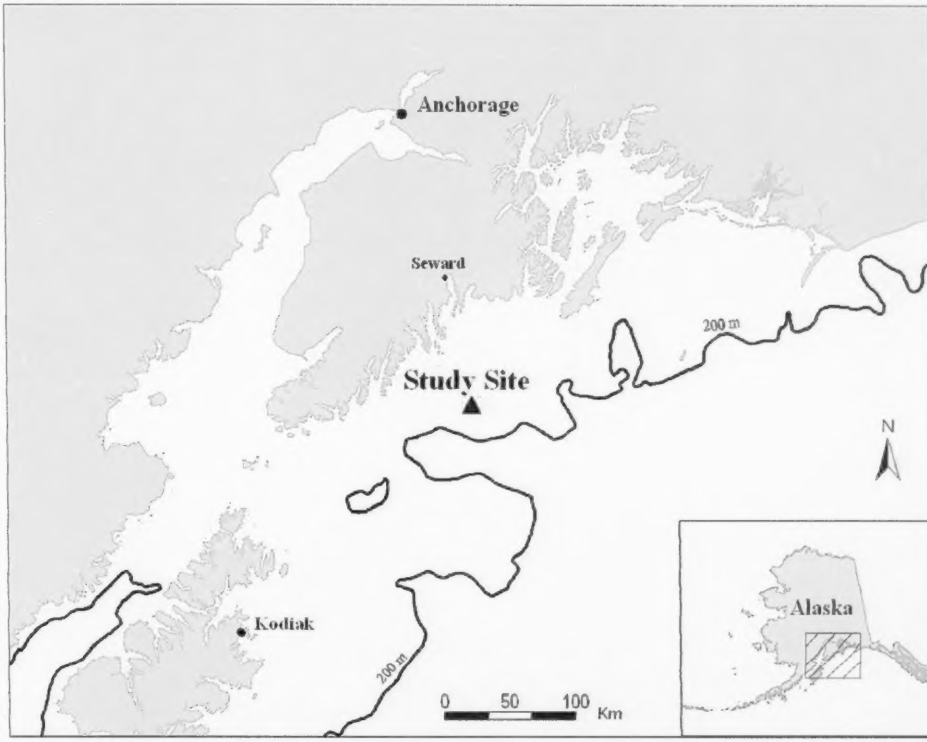

Figure 1.—Location of the study site in the Gulf of Alaska.

depths of 345 m with a pilot and an observer. It is outfitted with video cameras, halogen lights, a laser scaling device, gyro compass, voice communications equipment, and a transponder. The transponder allows tracking of the vehicle by the submersible's surface support vessel, which has GPS capability. During the survey dives, positional fixes were taken at 30-second intervals.

The video equipment consisted of an externally mounted Hi-8 video camera pointed downward at an angle of 45° and an internal video camera positioned parallel to the seafloor. The cameras were used to record images of the seafloor and associated benthos, while an audio track was used to record observer comments. A digital camera was used by the observer to take still photographs.

The primary purpose of the surveys was to collect information on red tree coral, *Primnoa* sp., abundance, distribution, and habitat associations at locations where past NMFS trawl surveys had brought up the species as bycatch. Survey sites ranged from waters along the southeast part of the Kenai Peninsula, southeastward to the Fairweather Grounds in the vicinity of Yakutat, Alaska.

Twenty dives were made during the cruise. This report details the observations made during one dive at 59°14.88′N, 149°13.27′W, (about 100 km south of Seward, Alaska) on 26 June 2001 (Fig. 1). Although no red tree coral was observed during the dive, juvenile red rockfish were observed in close association with sponges.

The pilot headed the submersible in a general eastward direction maintaining close proximity between the vessel and the seafloor. When boulders were noted, the pilot slowly approached these habitat features for close-up observations, and the boulders were slowly circled. The volumes of the boulders were calculated by estimating length, width, and height using the onboard laser scaling device. Volume estimates were made for only the sections of the boulders protruding above the seafloor.

If sponges were attached, the volume of the sponge was calculated using length, width, and height estimates. Volumes of individual sponges were expressed as a percentage of the volume of the boulders. The sponges were then closely inspected for the presence of juvenile red rockfish, counts were made of the number of rockfish if present, and the laser scaling device was used to estimate their lengths. Epifaunal invertebrates other than sponges that were attached to the boulders or present on the surrounding seafloor were noted, as were any fish species present.

Results

The total length of the transect completed by the submersible was 865 m. Water depth at the site was 148 m with

a temperature of 6.6°C. Underwater lateral visibility was about 10 m. The seafloor was flat, and the substrate consisted of a fine silt-sand mixture, with occasional boulders encountered at intervals of about 10 to 20 m. The only three-dimensional relief was that provided by boulders and sponges, and occasional seawhips.

Vertebrate fauna encountered were typical of fauna found on similar substrate in the GOA, and included arrowtooth flounder, *Atheresthes stomias*, and other unidentified flatfishes; spiny dogfish, *Squalus acanthias*; schools of adult Pacific ocean perch, *Sebastes alutus;* and rougheye rockfish, *Sebastes aleutianus,* (the two species could not be distinguished underwater); pricklebacks (Stichaeidae); eelpouts (Zoarcidae); and poachers (Agonidae). Macroinvertebrates present included squat lobster, *Munida quadrispina*; hermit crabs (Paguriidae); spot shrimp, *Pandalus platyceros;* bryozoans; hydroids; brachiopods; seawhips (Pennatulacea); seastars (Asteroidea); brittlestars (Ophiuridae); sea urchins (Echinoidea); sea cucumbers (Holothuridae); and gastropods, in addition to the sponges.

Eighty-two boulders ranged along the transect, from 0.1 to 2.0 m along their longest axis, and most were roughly spherical in shape. Sponges were present on 66% of the boulders. Although other epifaunal invertebrates such as hydroids, bryozoans, brachiopods, basketstars, and seastars were also present on the boulders, sponges contributed most of the invertebrate biomass. In addition to habitat structure provided by these taxa, a small amount of cover was provided by occasional small indentations or caves located between the base of the boulders and the surrounding seafloor, presumably formed by water currents.

Fifty-four sponges were seen on the transect; all were attached to boulders. *Aphrocallistes* sp. made up 87% (47) of the sponges. In addition, five glass sponges, *Rhabdocalyptus* sp., and two unidentified sponges were present. *Aphrocallistes* sponges were roughly spherical in shape and had many finger-like protuberances projecting from the sponge body. *Rhabdocalyptus* sponges were generally cylindrical in shape, and the walls of the sponge body were smooth. Estimated volumes for both types of sponge combined ranged from 0.1 m^3 to 8.4 m^3 ($\bar{x}$ = 1.1 m^3). Volumes of sponges expressed as a percentage of the volume of the boulders to which they were attached ranged from 10% to 700% ($\bar{x}$ = 195%).

Eighty-two juvenile red rockfish were noted in the immediate vicinity of sponges along the transect. These fish ranged in length from 5 to 10 cm, and were probably 2–3 years old. All appeared to be of the same species, although positive identification was not possible from visual observation from the submersible. Only those boulders with attached sponges harbored juvenile rockfish. Of the 82 rockfish observed, 79 (96% of total) were associated with *Aphrocallistes* sponges. The remaining three (4% of total) rockfish were associated with *Rhabdocalyptus* sponges. Numbers of juvenile red rockfish per sponge ranged from 1 to 10. These fish were usually first observed hovering as individuals or small schools a short distance (< 0.5 m) above the sponges attached to the boulders. They invariably darted into the body of the sponge for cover as the submersible approached (Fig. 2). If the submersible remained motionless next to the sponge they would emerge from the sponge after several minutes had elapsed. They did not appear to be frightened by the submersible's lighting system, disappearing into the sponge only when the submersible began to move. Statistical analyses showed no correlation ($P > 0.05$) between sponge volume and number of juvenile red rockfish present, or between the sponge volume/boulder volume ratio and number of rockfish.

Discussion

This survey shows that sponges of the genus *Aphrocallistes* can provide important habitat for juvenile red rockfish. Although several species of sponge were present along the transect, almost all juvenile red rockfish were associated with *Aphrocallistes*. Furthermore, the rockfish showed a clear preference for epifanual cover as all rockfish were associated with sponges rather than the small caves and crevices present at the base of many of the boulders.

Tyler and Bohlke (1972) listed 39 species of fish in the Caribbean known to have some association with sponges, and categorized sponge-dwelling fish as either 1) morphologically specialized obligate sponge dwellers, 2) morphologically unspecialized obligate sponge dwellers, 3) facultative sponge dwellers, or 4) fortuitous sponge dwellers. They stated that fishes in category 1 were likely to spend their entire lives, with the possible exception of the larval stage, within the bodies of the sponges they inhabit. Fishes in category 2 may leave the host sponge to feed nocturnally. Facultative sponge dwellers (category 3) spend part of their lives on or in sponges, but have been observed in other types of habitat. Finally, fortuitous sponge dwellers (category 4) comprised a variety of families, all of which are known to occupy a wide variety of habitat types. These families include gobies, clinids, pomocentrids, gobiescoids, apogonids (Tyler and Bohlke, 1972), a xenogongrid (Bohlke, 1957), and two scorpaenids: *Scorpaenodes tredecimspinosus* (Eschmeyer, 1969) and an unidentified scorpaenid species (Metzelaar, 1922). In addition to the aforementioned families, juvenile creole wrasse, *Clepticus parrae,* have been observed fortuitously associated with sponges in the Bahamas (Colin, 1975).

The juvenile red rockfish that were observed during this study probably can be classified in category 4, fortuitous sponge-dwellers. Personal observations made by the authors during other investigations (unpubl. observ.) in the GOA indicate that juvenile red rockfish of the size encountered in 2001 can occupy a wide variety of habitat types, including other species of sponge, gorgonian coral colonies, and interstices between cobbles and boulders. The fact that the juvenile rockfish observed in this study were associated only with *Aphrocallistes* sponges can likely be attributed to the paucity of other available habitat types along the transect.

The lack of a clear relationship between sponge size and number of juvenile

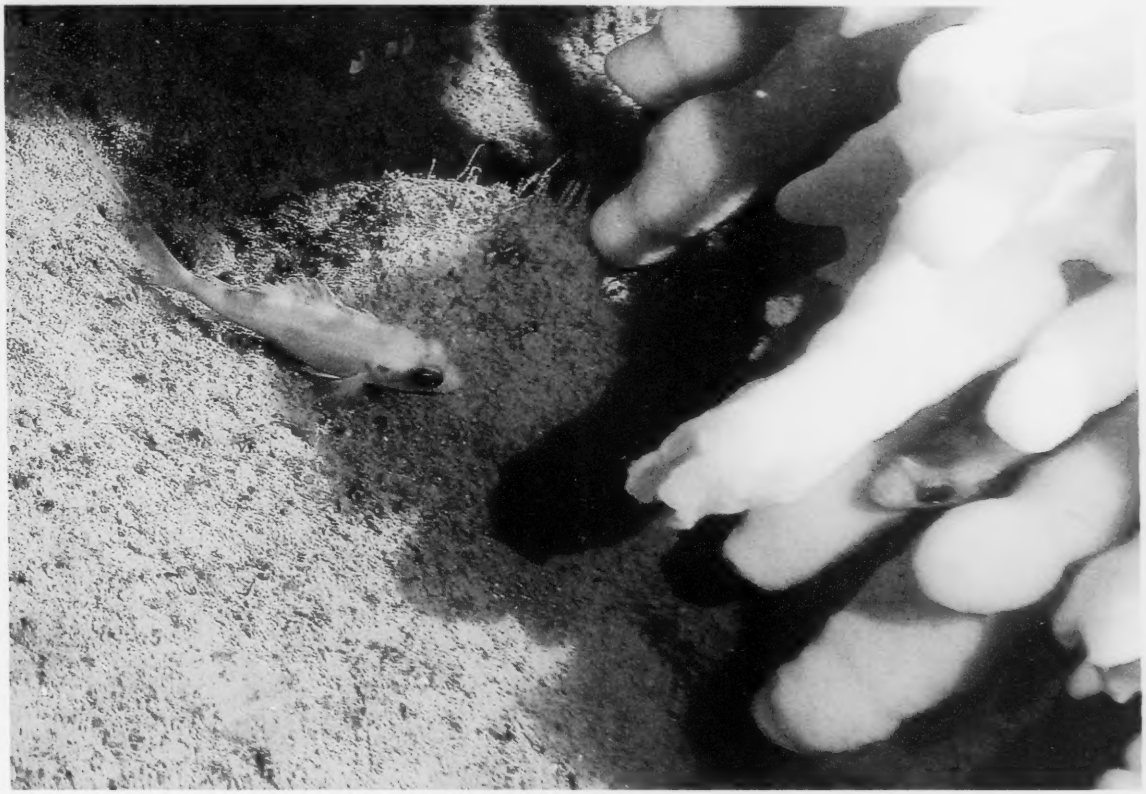

Figure 2.—Juvenile red rockfish, *Sebastes* sp., associated with *Aphrocallistes* sp. sponge in the Gulf of Alaska.

red rockfish harbored was surprising, but can most likely be attributed to the fact that the fish preferred those sponges with many finger-like protuberances in which to seek cover. Sponges in general are highly polymorphic, and there was no clear relationship between sponge size and number of protuberances present on the body of the sponge. Likewise, the fact that only 4% of the rockfish were associated with *Rhabdocalyptus* sponges can likely be attributed to the fact that this species is cylindrical in shape with a smooth texture, and affords minimal cover.

The locations of nursery grounds for many *Sebastes* spp. in the northeastern Pacific are generally not well known. Based on the fact that juvenile rockfish are lacking in offshore trawl catches but are often caught at nearshore trawl sites, Carlson and Haight (1976) hypothesized that nearshore hard-bottom coastal areas and adjacent fiords serve as nursery grounds for Pacific ocean perch, the most abundant rockfish in Alaskan waters. Their hypothesis was supported by observations made from a submersible (Carlson and Straty, 1981), during which thousands of juvenile red rockfish (6–8 cm length), believed by the authors to be Pacific ocean perch, were observed over just such habitat. The observations made during our investigation suggest that juvenile red rockfish may not exclusively use nearshore sites as nursery areas. The location at which we observed juvenile red rockfish of a size similar to those observed by Carlson and Straty (1981) was about 50 km offshore in the GOA; furthermore, the substrate at our study site was mostly a sand and silt mixture rather than rocky.

In conclusion, our observations show that *Aphrocallistes* sponges provide habitat for juvenile red rockfish. The association is fortuitous, in that many juvenile red rockfish have been noted in a wide variety of other habitat types in the GOA (personal observ.), including other types of emergent epifauna, as well as in cover provided by nonliving substrates such as boulders and cobbles. The fish observed in this study probably benefited from their association with the sponges through predator avoidance. The sponges provided most of the vertical relief on the seafloor at this site, with the exception of the boulders to which they were attached. Disruption of this type of sponge community by bottom trawling would be expected to have a negative impact on juvenile red rockfish survival in areas where other types of cover are not available.

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Observations on Fisheries Activities at Navassa Island

M. W. MILLER, D. B. MCCLELLAN, and C. BÉGIN

Introduction

Despite extremely high rates of primary production in coral reef ecosystems, actual yield of coral reef fisheries is relatively low. In addition, the ecological complexity, richness, and specialized life histories of coral reef organisms and communities make them particularly susceptible to overexploitation (Birkeland, 1997). Results of such overexploitation in Caribbean islands are seen in the documented drastic declines in catch-per-unit-effort, size structure, and/or species shifts in the fisheries of Jamaica, Grenada, the U.S. Virgin Islands, and others (Koslow et al., 1988; Jeffery, 2000; Rogers and Beets, 2001). Indeed, subsistence fishing to support a single family has been described as impacting target populations on the scale of a whole bay in the U.S. Virgin Islands (Coblentz, 1997).

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ABSTRACT—Unmanaged and unquantified artisanal fishing is ongoing at Navassa Island, a small oceanic island about 70 km west of Haiti that is part of the U.S. Caribbean Islands National Wildlife Refuge. Concern has been expressed regarding the possible impact of these fishing activities on reef resources, and no quantitative catch or effort data are available. However, informal qualitative observations made during a cruise in November 2002 suggest that escalation in fishing activity (and impact) has occurred since previous observations made in April 2000. Namely, size structure of fish was markedly reduced and the adoption of net fishing has allowed the exploitation of queen conch, Strombas gigas, *and hawksbill turtles,* Eretmochelys imbricata.

Navassa Island is small and, although claimed by the United States as part of the Caribbean Islands National Wildlife Refuge, sovereignty is disputed by Haiti. Due to its isolation, uninhabited status (except for temporary squatters), and some preliminary quantitative visual fish census work, Navassa Island has been described as displaying a relatively pristine reef community (Anonymous, 2000; Grace et al., 2000; Miller and Gerstner, 2002). However, this interpretation has also been questioned due to the observation of ongoing fishing activity by migrant Haitians, the complete lack of quantitative information regarding the intensity of this fishing activity, and the potential for its rapid escalation (Collette et al., 2003; Grace et al., 2000; Miller and Gerstner, 2002)

Navassa Island is about 5 km^2 in area and is comprised of a raised plateau surrounded by cliffs which reach down to a submarine terrace at 23–30 m depth (Fig. 1). The primary fishery habitats are reef walls formed by the cliffs and large boulders (or "calves" as analogous to the chunks that fall off of icebergs) that have been dislodged from the cliffs, scattered patch reefs and hardbottom areas on the 25–30 m terrace, and deeper reef slopes and shelves (>30 m) farther offshore that have not been well described.

Navassa Island's oceanic position in the Windward Passage (Fig. 1) exposes it to substantial physical energy. The east coast, particularly, bears the brunt of persistent swells, regular storms, and hurricanes. Inshore and backreef habitats, which are important in the life history of several reef fish groups, are largely absent.

Despite its status as a National Wildlife Refuge, fisheries at Navassa Island are effectively unmanaged as regulations are not well publicized and enforcement is non-existent due to Navassa's remote location, surrounded by international jurisdictions. Fishing activities are undertaken by migrant Haitian artisanal fishermen, and these activities appear to have been ongoing since at least the 1970's. Anecdotal observations from a previous NMFS expedition[1] reported five Haitians fishing out of a 4.3 m sailboat along the north/northwest coast and "catching only small grunts [Haemulidae] and one small barracuda [*Sphyraena barracuda*]". Other anecdotal accounts suggest that some technological escalation in this fishery had occurred between scientific expeditions which had occurred in 1997 and 2000. That is, no motors were observed in 1997, while all the vessels observed during the 2000 expedition had 10–15 h.p. motors (Anonymous, 2000; Miller[2]).

Quantification of catch or effort has not been undertaken for the Navassa Island fisheries, though 0–4 small boats per day were observed employing trap and handline fishing during the 2000 expedition (Miller and Gerstner, 2002). Because of this complete lack of quantitative fisheries information and inadequate quantification of reef fish status (particularly in the recent past), the impact of these ongoing subsistence fisheries is difficult to assess. Underwater visual transect census conducted in the western nearshore reef habitats (<20 m) in 2000 reported moderate to high density of large reef fishes (including larger species of Lutjanidae, Serra-

[1] Miller, G. C. 1977. Cruise results for *Oregon II* 77-08 (80), Navassa Island resource assessement survey. Unpubl. 12 p. rep. on file at NMFS Southeast Fisheries Science Center, Miami, FL 33149.

[2] Miller, M. W. NMFS Southeast Fisheries Science Center, 75 Virginia Beach Dr., Miami, FL 33149. Personal observ., 2000.

nidae, and Scaridae), suggesting minimal fishery impact in these nearshore habitats (Miller and Gerstner, 2002) though other reports suggest that large fishes had already been greatly reduced at least in the northwest (Collette et al., 2003). Miller and Gerstner (2002) also suggested that strong socioeconomic "push" factors in Haiti made it likely that fishing intensity and impact at Navassa would increase, possibly rapidly. It is well known that reef communities can be readily overfished (Coblenz, 1997).

There are many definitions of overfishing, most of which cannot be evaluated in the absence of quantitative fisheries statistics (e.g. growth overfishing, Malthusian overfishing). However, qualitative fisheries information can be suggestive of patterns indicating, for example, serial overfishing, (i.e. a progression where the largest and most vulnerable species are removed first, followed by shifts to smaller, less-desirable targets as each group is depleted). For Navassa Island, such qualitative observations are all that are available, and the following observations are offered as indicative of such a pattern.

Methods

Observations were made at Navassa from 29 October to 8 November 2002 based aboard the R/V *Coral Reef II* (Research Vessel of the John G. Shedd Aquarium, Chicago IL). The primary objective of the expedition was the assessment of reef condition (both benthic and fish assemblages (Miller, 2003)). Fishery observations were opportunistic, and each day, note was made of how many fishing boats were present around the island. In addition, direct interviews and observations were made with three different boats on different occasions. A small (~15 ft) boat from the R/V *Coral Reef II* was used to approach the Haitian fishing boats and engage the occupants in conversation. The interviews were conducted in French and designed to obtain information directly from the fishermen on their fishing practices and catch. Also, the interviews afforded an opportunity to observe the catch directly (species and approximate amounts and sizes) that was visible in each boat, though thorough unpacking or exact measurements were not undertaken.

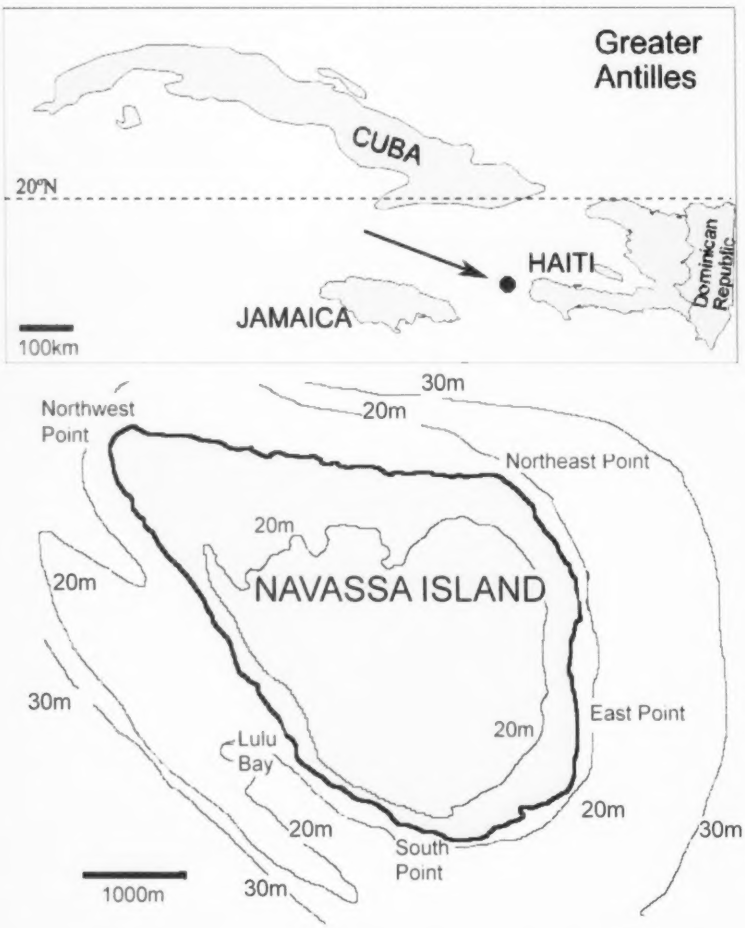

Figure 1.—Map of Navassa Island and its position in the Greater Antilles

Results and Observations

Boat Presence and Characteristics

Upon arrival on 29 October, one expansion of fishing activity impact (since the observations in April 2000) was immediately apparent: the presence of an extensive temporary mooring system in the relative shelter of Lulu Bay with four fishing boats moored there. Moorings consisted of bottle floats tied to a large rock anchor (Fig. 2) on the bottom to hold the sterns while the bows of the boats were secured with lines to the island cliff. These four boats were present for the next 2 days, but apparently they all left on the morning of 1 November. A new group of boats began arriving on 5 November, and four boats were again present at the end of our observations.

The open boats are wooden and about 6–9 m in length. One of the boats we observed was powered only by sail and paddles (Fig. 3), but each of the others had a 10–15 h.p. outboard motor (Fig. 4). The motors are used only intermittently to conserve fuel, and several fishermen told us that they had run out of fuel. Thus, they would be sailing home. One of the interviewed boats had an ice box for holding the catch, but the rest did not.

Fishermen were observed smoking and salting fish both in their boats and on the island. Fishing boats had between 3 and 6 persons aboard with 4 being the mode.

Fishing Practices

Three boat crews were interviewed and gave consistent information regarding their fishing practices. They travel from Haiti (~ 1 day each way), navigating by the sky (sun/stars) and their trips last 8–10 days. They indicated that they did not fish in any other areas, either in Haiti or in transit. One crew indicated that there were 10 boats from a single Haitian village that fish Navassa Island in groups of four boats at a time (consistent with our direct observation). One crew also indicated that they ceased trips for some seasonal periods, "after November," but this is not clear, and fishing activities have resumed at least by April based on observations from the 2000 cruise (Miller and Gerstner, 2002).

Fishing activities were concentrated along the north slope and around the more protected southwest coast terrace, and involved hand lines, traps, and nets (described below). No in-water fishing activities (e.g. via free diving or hookah) nor any tendency for the fishermen to swim were observed, with the exception of a direct transit from one boat to another.

The traps used were modified Antillean Z-traps constructed of bamboo with 3–4 cm mesh size (Fig. 5) and were deployed without bait. The bamboo is most likely transported to Navassa Island and traps are constructed on site as the finished traps were larger than the beam of the boats (Fig. 4). Hand lines were monofilament rigged with 2–4 small hooks and a small rock tied to the bottom for weight. Bait was anything not consumed by the fisherman; sand tilefish, *Malacanthus plumieri,* was most commonly observed being cut up for bait. Nets were some sort of entangling net such as a trammel, trawl, or purse, but we did not directly observe net use practices.

Catch Observations

A diverse array of taxa appeared in the fishermen's catch, as observed in their boats and in underwater refuse piles at the mooring site at Lulu Bay (Table 1, Fig. 6–9). The dominant species observed in the catch were queen conch, ocean triggerfish, schoolmaster snapper, and bar jacks. Other common taxa included juvenile hawksbill turtles, spiny lobster, yellow stingrays, squirrelfish, surgeonfish, trunkfish, barracudas, and black durgons (see Table 1 for scientific names). Some snapper and red hind were observed, but most were smaller than 30 cm and many were less than 20 cm. Only one parrotfish was observed.

Figure 2.—Rock anchor in Lulu Bay used in temporary mooring system for fishing boats.

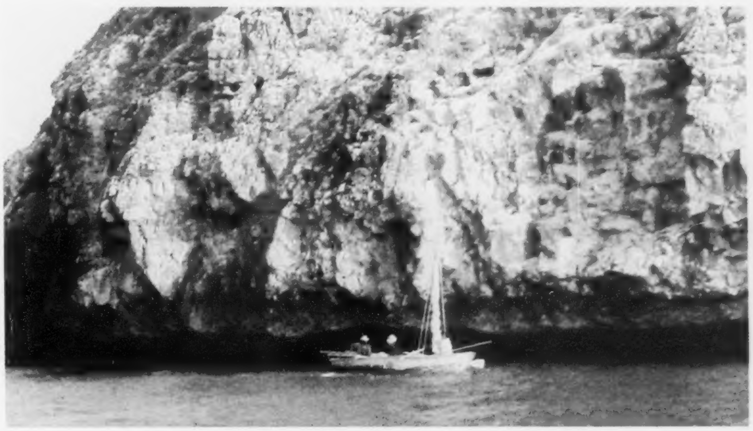

Figure 3.—Single sail-powered boat observed.

Discussion

Several qualitative differences in the fisheries activities at Navassa Island were noted between the expeditions in April 2000 and November 2002. First, the use of nets was not observed in 2000. Fisheries studies in Papua New Guinea have found a pattern of adoption and increased reliance on net fishing (compared to spearfishing, hook and line, and traps) as larger fishes are depleted (Lock, 1986, cited in Jennings and Lock, 1996). Thus it is plausible to interpret this observed

shift in Navassa Island fishing activity as a possible indicator of depletion.

However, a more direct indicator of depletion is the qualitative observation of relative finfish sizes between the two sets of observations. Large red-colored snappers were observed in the catch in 2000 (>40 cm) while the vast majority of caught fish observed in 2002 (excluding barracuda) were less than 30 cm. This small size structure of the reef fish assemblage at Navassa Island is also born out in extensive reef fish visual censuses conducted during the expedition (McClellan and Miller, 2003).

The adoption of net fishing appears to have had great impacts on the nature of the catch, allowing the exploitation of new species. Fishermen reported that both queen conch and sea turtles were caught by net, and this report is consistent with direct observations in 2000 (Miller[2]) when neither net fishing nor queen conch and sea turtle harvest were observed. In contrast to the finfish catch, the abundant queen conch catch observed in 2002 was composed of large, mature animals (25–30 cm TL) estimated to be 6 to 9 years of age (Glazer[3]), suggesting that queen conch exploitation is in the early phases.

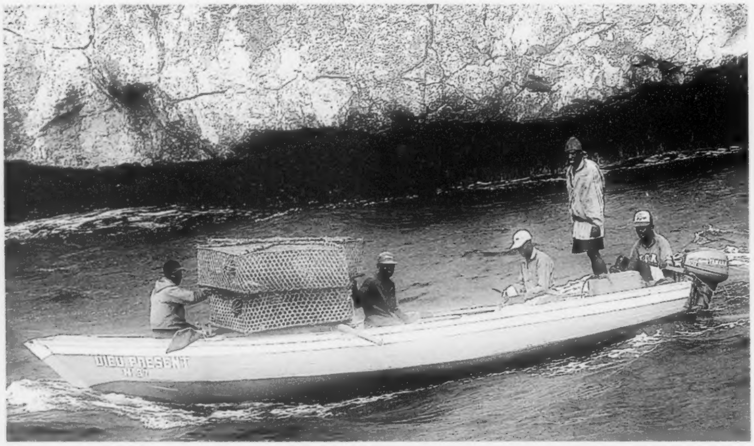

Figure 4.—Typical Haitian fishing vessel with 10–15 hp motor.

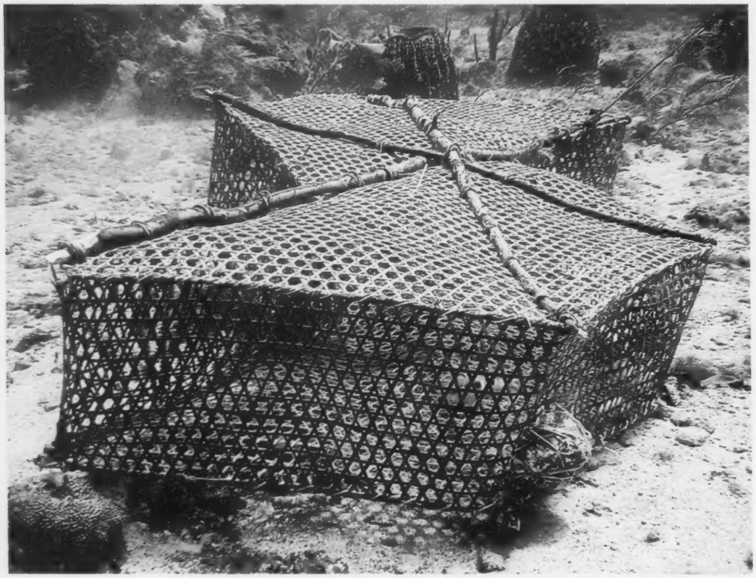

Figure 5.—Typical Antillean Z-trap used at Navassa Island.

While the hawksbill turtles observed were not large, it is likely that Navassa Island serves as a juvenile habitat similar to other offshore islands in the Caribbean such as Buck Island (St. Croix, USVI) or Mona Island (Puerto Rico). We observed about 8 captured hawksbill turtles and a total of <10 live hawksbill turtles in the water (in over 300 individual dives). Evidence that the sea turtle harvest is ongoing was observed in the underwater trash piles at Lulu Bay where several (~ 10) piles of turtle bones/plates were observed, but no carapaces, which may have been taken to Haiti for the curio trade (Fig. 9).

The actual method by which queen conch and turtles are harvested with nets is not clear, and we did not directly observe net fishing activities. Shallow coastal habitats are absent at Navassa Island and the only conch habitat we observed is on an interspersed sand/patch reef terrace surrounding the island at 25–30 m depth. It is not clear how these small boats could tow nets in a way to snag conch from such a depth and habitat. Queen conch were captured by fish traps off south Florida (Sutherland and Harper, 1983). However, the fish traps we observed at Navassa Island did not appear to have openings that would accommodate the size of conch we observed in the fishing boats. We hypothesize that the nets are baited and laid horizontally on the substrate for a period of time to attract foraging conch and fishes onto the net before being

[3] Glazer, Robert. Florida Fish and Wildlife Conservation Commission, Florida Marine Research Institute 2796 Overseas Highway, Ste. 119, Marathon, FL 33050. Personal commun., 2004.

Figure 6.—Miscellaneous finfish catch from hook and line in the only ice chest observed.

hauled to the surface (i.e. trammel netting). While it is not certain if harvest of queen conch and sea turtles was intended by the adoption of net fishing, the quantity of conch caught and this seeming need for such specialized net usage to procure conch suggest that they are specifically targeted by the Haitian fisherman. Similarly, the ratio of our observations of live and caught sea turtles (10:8 in 300 dives versus 3 boat interviews) suggests that sea turtles are targeted to some extent, possibly by deploying nets around a turtle after it is observed surfacing.

Ruddle (1996) notes that the intensity of reef fisheries is often determined by the availability of alternative economic activities or employment outside the fisheries sector. The poor economic conditions in Haiti may thus imply that fishery exploitation at Navassa is bound to increase. This paper adds to a growing information base of qualitative observations regarding fishing activities at Navassa which, though not yet adequate for clear documentation of the fishing regime, represents the only insight available.

Table 1.—Summary of taxa and approximate number in the catch that was exposed and visible in Haitian fishing boats observed at Navassa Island during 29 Oct–9 Nov 2002.

Common name	Scientific name	Catch
Spiny lobster	*Panulirus argus*	<10
Hawksbill turtle	*Eretmochelys imbricata*	<10
Black durgon	*Melichthys niger*	<10
Yellow stingray	*Urolophus jamaicensis*	<10
Scrawled filefish	*Aluterus scriptus*	<10
Schoolmaster	*Lutjanus apodus*	<10
Sand tilefish	*Malacanthus plumieri*	<10
Snappers	*Lutjanus* spp.	<10
Great barracuda	*Sphyraena barracuda*	<10
Squirrelfish	*Holocentrus* sp.	<10
Queen conch	*Strombas gigas*	10–100
Trunkfish	*Acanthostracion quadricornis*	10–100
Ocean triggerfish	*Canthidermis sufflamen*	10–100
Surgeonfish	*Acanthurus* spp.	10–100
Bar jack	*Carangoides ruber*	10–100
Stoplight parrotfish	*Sparisoma viride*	1
Queen trigger	*Balistes vetula*	1
Stingray	*Dasyatis* sp.	1
Sharks, small	unknown	1
Coney	*Cephalopholis fulvus*	1
Red hind	*Epinephelus guttatus*	1

Although quantitative analysis is precluded by the lack of historical populations estimates, comparison with recent observations in a protected marine reserve at Little Cayman Island in December 2002 shows much greater snapper and grouper numbers and sizes than observed at Navassa (Schull et al., 2003). Smaller grouper such as coney, *Cephalopholis fulva*, and graysby, *C. cruentata*, are now targeted by Haitian fishermen. If local stocks are necessary for repopulating these fishes, it is likely that the vast majority of settling juveniles are caught before they reach sexual maturity. It is also highly likely

Figure 7.—Large gravid lobster.

Figure 8.—Mixed catch including small hawksbill turtle, queen conch, and finfish.

Figure 9.—Underwater refuse pile observed at Lulu Bay containing turtle bones and ventral plates, fish skin, and bamboo.

that substantial shifts in species composition have already occurred in the Navassa Island fishery.

These observed patterns (reduced abundance and size structure of highly desirable target stocks such as snapper and grouper, coupled with exploitation of new stocks with novel gear such as queen conch with nets) are consistent with expectations under a scenario of serial overfishing. Hence, any future attempts at fishery management or regulation for Navassa need to take into account the likelihood of an already-shifted baseline.

Concerted effort must be applied to collecting quantitative catch and effort data. Such fishery information is a prerequisite for beginning to think about a possible fishery management strategy for Navassa or for understanding the relationship between fishing pressure and reef status.

Acknowledgments

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Editorial Guidelines for the *Marine Fisheries Review*

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